

**Era of Shaky Sustainability Policies,  
A System Dynamic approach on trend of future policies**

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**Introduction**

We live in an unsustainable era. Naming just one problem, greenhouse gas (GHG) emissions resulting from non-renewable energy resources, especially fossil fuels, is a profound environmental problem which is rapidly changing the climate and consequently life on planet earth. Coupling the environment and economy can prevent more severe problems. Reciprocal benefits presented in Figure 1 can hold both economy and ecology in a stabilized and long-lasting position.

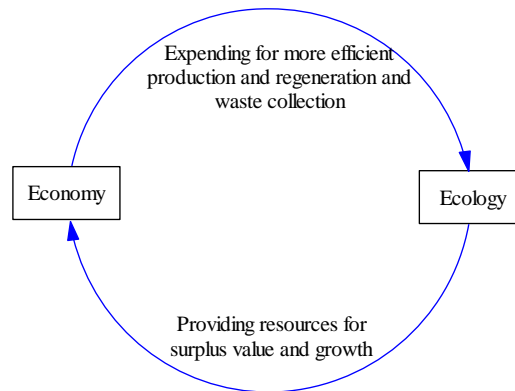


Figure 1: Coupling of Environment and Economy

Bruin and Dellink (2010) named some restrictions that prevent systems to adapt in an optimal manner towards sustainability, like the amount of funds available for adaptation, uncertainty regarding the effectiveness of adaptation, inertia, and finally restrictions on the flexibility of adaptation and the notion that adaptation knowledge may need to be accumulated over time. This article presents a general view over the mechanisms created to build sustainability and the reaction of the social system to them. It aims to increase the understanding of how we can improve the policies from a macro perspective.

For years, individuals, firms, governments and international organizations put a lot of effort into developing and adopting sustainable technologies, policies and behaviors. Despite all these efforts, results are not always satisfactory. The ineffectiveness of the policies and intentions are evident in different forms, such as:

- No serious commitment: Many researchers suggest that during times of recession, economic issues replace environmental issues, for more immediate concerns for consumers. This can illuminate the cyclical pattern in terms of consumers' responsible environmental behavior (Kalafatis, Pollard, East and Tsogas, 2012).
- Emphasizing economic factors: Canadian government is formally withdrawing from the Kyoto protocol. This was the motivation for writing this paper which tries to understand the dynamic in which the decision has been made, despite awareness of sustainability problems. The rationale behind the decision, from Canadian government perspective is that "Canada's obligations under Kyoto would cost \$13.6bn, which is \$1,600 from every Canadian family "(Kent, 2011).

- No measurable result: Policy actions trigger series of events and feedbacks that sometimes undermine the policy over time and even exacerbate the original problem. For example, Kyoto protocol as a policy action was supposed to make a difference in GHG concentration due to series of incentives and change of behaviors. However, it was not a complete success and in cases like Canada and USA, we witness a "policy resistance" (Sterman, 2000).

This article studies the behavior of larger systems and tries to explain the rationale behind such behavior. For the theoretical model behind the discussion, we compare and contrast ecological modernization and Brundtland formulation of sustainable development, as two approaches to sustainability issue.

### **Methodology**

What is behind the policy resistance and what are the consequences? In this paper, we analyze the root cause of the improper coupling from a system dynamics perspective and attempt to measure the effect of different scenarios and solutions to make the coupling work.

System Dynamics (SD) is an approach to understand the behavior of complex systems over time. It deals with internal feedback loops and time delays that affect the behavior of the entire system. Some characteristic of the sustainability policy context make SD a good method of analysis, for example, complexity of the environment in which unsustainability problem arise and in which policies are made, need to persuade different stakeholders and need to experiment and the measure the costs and effects of the proposed policy (Ghaffarzadegan et al., 2011). System dynamics models are able to include feedbacks and are easy and not costly illustration of the sources of policy resistance. Moreover, the system dynamic approach facilitates learning through extensive experiments and brings different stakeholders' incentives in one model. (Ghaffarzadegan et al., 2011).

SD is a very useful tool for predicting the trends and answering whether the current causes and effects lead to equilibrium at the end or result in continuous increase or decrease in the value of the variables. Considering the concept of sustainability which means continuity of system function over the time, SD seems to be an appropriate methodology.

### **Mechanism of Moving towards Sustainability: Ecological Modernity Paradigm**

Economic growth and rise in production and consumption increase the amount of harm that human civilization cause to the environment and decrease the level of non-renewable natural resources. Consequently, the knowledgeable monitoring members of society initiate notifying about the consequences such as pollution and depletion. Dissemination of this information over time creates consensus about the severity of environmental problem and leads to commitment to a counter-action. The commitment with delay results in some sustainable solutions and diffusion of the solutions can lead to less consumption, less harm to the environment. The above statement has been modeled by balancing loops of B1 and B2 in Figure 2. This is the mindset behind current sustainability issues and mechanism of coupling under ecological modernity (EM) concept. EM, especially EM technological strand, characterized by an emphasis on technological innovations in environmental reform; a critical attitude towards government as a driving force and environmental policy maker and recognition of the role of market actors and dynamics in environmental reforms (Milanez and Buhrs, 2007; Mol and Sonnenfeld, 2000).

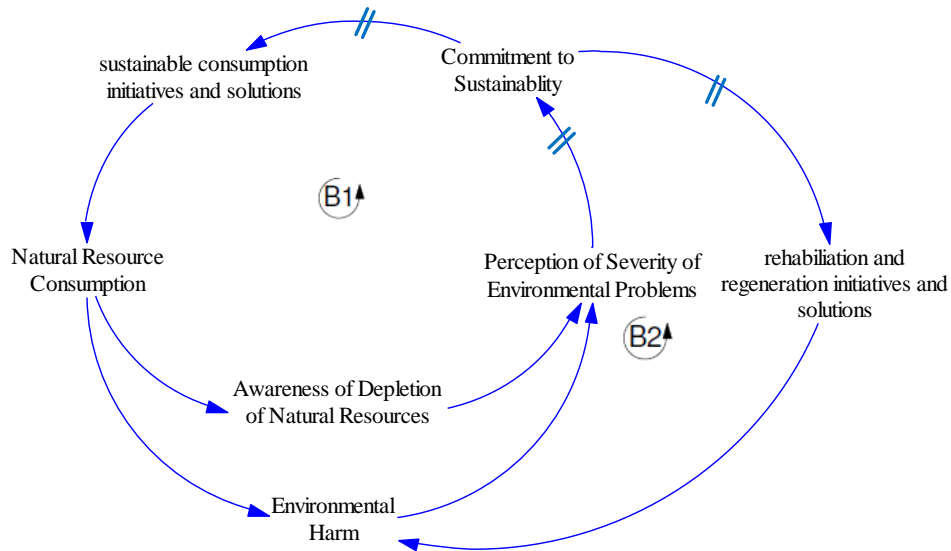


Figure 2: Casual loop diagrams behind spread of sustainability

### Resistance: the forgotten mechanism

Researchers have reported resistance to change of behavior, accepting and implementing sustainable solutions in different forms. In the individual level, we know that People don't want to follow the proper practices, even though they are fully aware of the practices and the reason to follow them. In organizational, sectional and societal level resistance exists as well. Arbuthnott et al. (2011) illustrated how renewal toward sustainability may be threatened by responses from established firms operating within traditional non-sustainable industry. Similarly, Harich (2010) showed the importance of dominant agent goals that conflict with the common good changes. Harich (2010) showed change resistance is the real problem that needs to be solve. In agreement with the mentioned arguments about resistance, we model the future of sustainability coupling with eyes on the issue of cost pressure. Our perspective is originated from the Canadian withdrawal and its raison d'être. We add the cost pressure mechanism in the form of balancing loops of B3 and B4 (Figure 3).

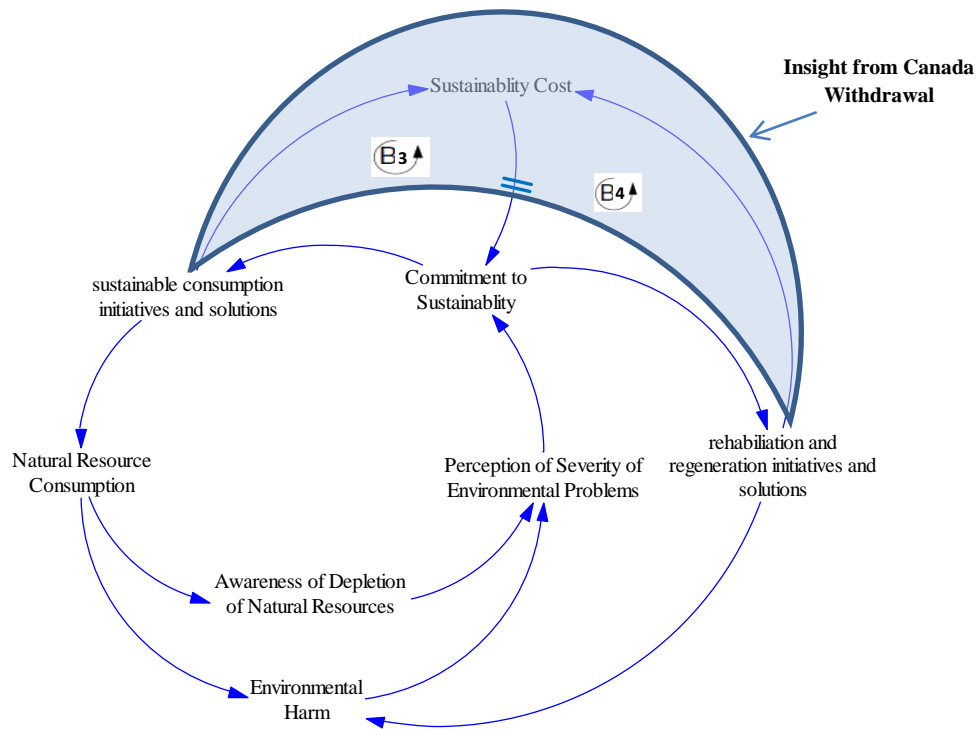


Figure 3: Balancing casual loop diagrams (resistance mechanism)

### Solution

In continue, we try to propose an initiative that can prevent this shaky and changing behavior. As a solution, we start with the principles of our economic system which is cornerstone of the world. It is based on maximizing profit for shareholders, consumerist view of human welfare and growth and profit. Ecological Modernization and preventive innovation are initiatives under this paradigm because EM doesn't challenge these undertakings. EM shows a longer-term view than neo-classical perspective through slower depletion of natural resources and considering future generations as stakeholders and the fact that firm have stakeholder view rather narrower shareholder view (Stubbs and Cocklin, 2008). However, EM is not a route to sustainable development (Baker, 2007).

We offer alter the model either to limit growth or to limit existing patterns of high consumption (Baker, 2007). To implement this change, we consider the following mechanism in the 3<sup>rd</sup> simulation:

- Increasing the share of knowledge-based economy in comparison with economic growth based on natural resources
- Decreasing the expectation of economic growth rate: This requires reduction of growth in societies, redefinition of economic success and considering environment in the economical indexes, sustainable bus business models (Stubbs and Cocklin, 2008), fundamental social, cultural and lifestyle change (Baker, 2006)

Besides, we also offer increasing efficiency of production by technological innovation, which is the mechanism related EM.

### Simulations and Results

In this paper, we run three simulations. First, the optimistic view of adopting sustainable solutions and policies by societies. Second, adding change resistance mechanism and the effect of cost pressure on commitment and third, adding a more holistic measure including both economic and environmental issues (instead of just looking at economic growth and feasibility) and its effect on accepting sustainable policies and initiatives. The classic



view makes balance between consumption and regeneration in long-term due to spread of sustainable solutions and also increases in the share of knowledge-based economy. The change resistance mechanism prevents the classic view and makes societies to take a shaky position about commitment to sustainability. Initially, they highly commit to counteractions, however after a while take a lower level of commitment due to cost and effect on economic growth and welfare. Meanwhile, the problem gets worse and again the loop will be repeated until we consume all the natural resources and destroy the ecology for the sake of economy. The third simulation with the new paradigm can bring balance between consumption/harm and regeneration/rehabilitation and makes the coupling work. The model and the results of simulation are presented in Figures 4, 5 and 6.

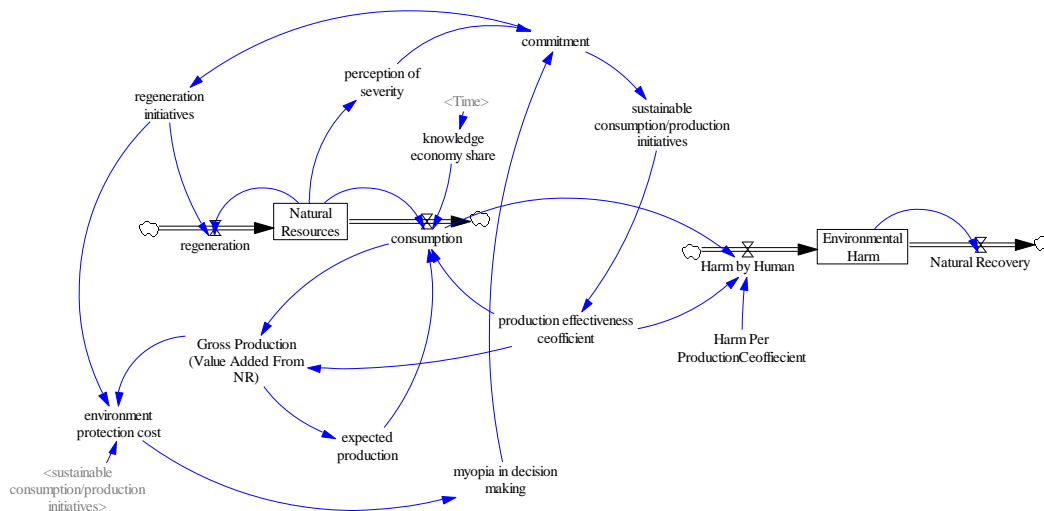


Figure 4: The Simulation Model

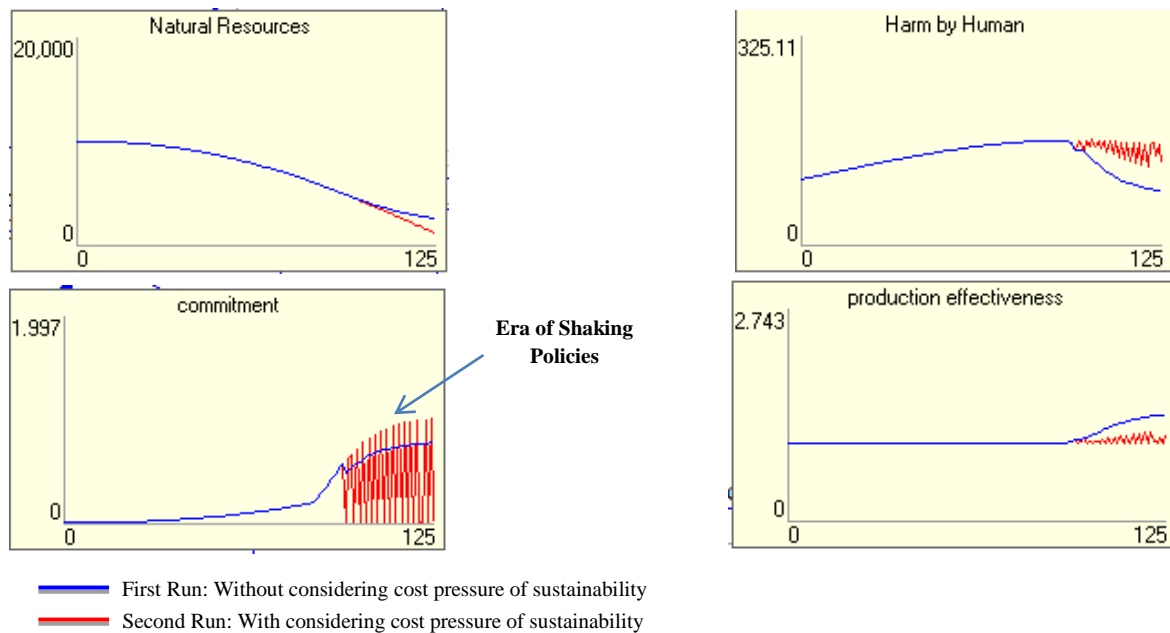


Figure 5: Result of 1<sup>st</sup> and 2<sup>nd</sup> runs<sup>1</sup> (without and with considering cost of sustainability) - EM paradigm

<sup>1</sup> The X-axis is time and Y-axes are: for "Natural Resources" variable, units of natural resources remaining all over the world; for "commitment" variable, the level of commitment to sustainability (between 0 to 1); for "Har by Human" variable, the amount of depletion of human resource in one unit of time, for "production effectiveness" variable, the level of improvement in production in terms of less consumption of natural resources or less harm to natural resources (between 0 to 1).

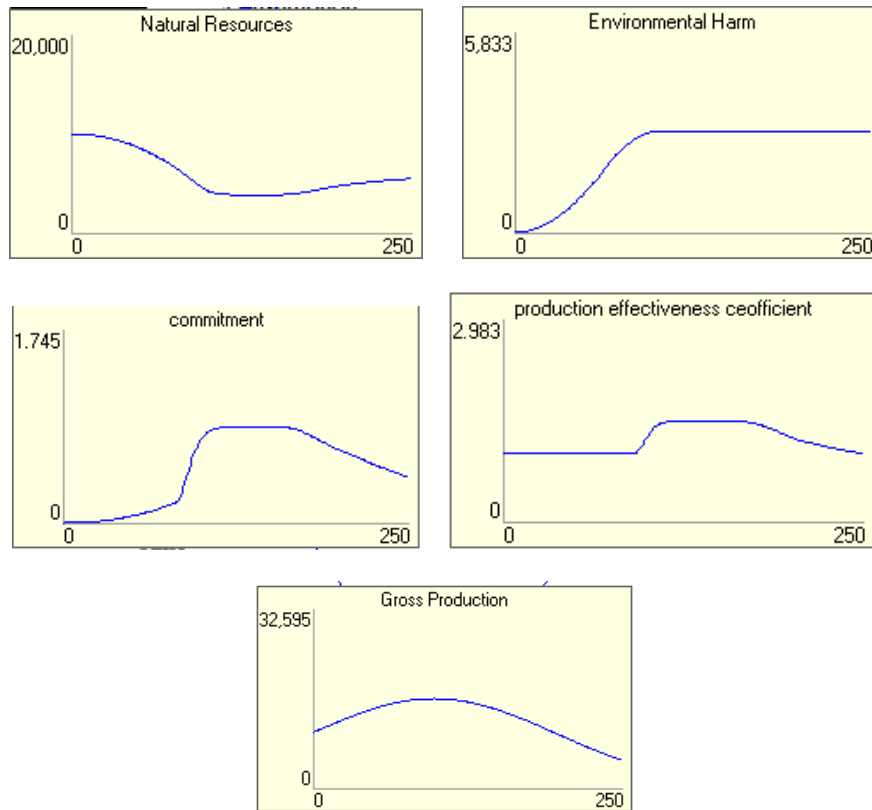


Figure 6: Results of 3<sup>rd</sup> simulation (changing consumerist behavior) - Brudtland formulation of sustainable development

### Conclusion and discussion

The simulation result shows that instead of focusing our activities on developing more advanced sustainable technologies and solutions, we should be more concentrate on changing paradigm of governmental and individual decision making and lifestyle. Policies under EM paradigm like taxes on natural resources, productivity growth for reaching life quality and environmental creation as a source of job creation and economic growth can postpone the sustainability. But in the long term, these also lead to depletion.

Replacing a combined measure which considers both environmental sustainability and economic growth to the current thirstiness for economic growth is a priority. Without changing the reference points, the coupling is temporary and the economy outweighs the ecology. Until then, decisions like Canadian government would be common which we call Era of shaky Sustainability Policies. In other words, if we want to prioritize between two major types of environmental behavior, curtailment and efficiency increasing (Black et al., 1985), the earlier is more important and more efficient. Curtailment is associated with discomfort for example not using air-conditioner in summer (Gardner and Stern, 2002) and less cost due to less consumption, while efficiency increasing is associated with cost for substituting old technologies with green solutions. This conclusion is a good starting point for debate on how we can change the promises of current social-economic system which undertake economic value creation superior to environmental and social goals.

Validating the model by using real dataset, focusing more on policies that can change the consumption behavior and their cause and effect mechanisms can be subjects for future research.

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We didn't use real dataset in the simulated model. We assumed that amount of natural resources is 10000 units, natural regeneration rate is 5% and expected economic growth is 1%.

## References

- Arbuthnott, A., Eriksson, J. & Thorgren S. (2010). Reduced opportunities for regional renewal: The role of rigid threat responses among a region's established firms, *Entrepreneurship and Regional Development*, 23(7-8): 603-635.
- Baker, S. (2007). Sustainable development as symbolic commitment: Declaratory politics and the seductive appeal of ecological modernisation in the European Union, *Environmental Politics*, 16(2), 297-317.
- Baker, S. (2006). *Sustainable Development*, London: Routledge.
- Bruina K., Dellink R. (2011). How harmful are restrictions on adapting to climate change?, *Global Environmental Change*, 21(1), 34-45.
- Kent P., Environment Minister, BBC News, <http://www.bbc.co.uk/news/world-us-canada-16151310>. Retrieved: 13 January 2012.
- Black, J. S. , Stern, P. C., & Elworth, J. T. (1985). Personal and contextual influences on household energy adaptations. *Journal of Applied Psychology*, 70, 3-21.
- Sterman JD. (2000). *Business Dynamics: Systems Thinking and Modeling for a Complex World*. Irwin/McGraw-Hill: Boston, MA.
- Gardner, G.T. & Stern, P.C. (2002). *Environmental Problems and Human Behavior*. Boston, MA: Pearson Custom Publishing.
- Ghaffarzadegan, N., Lyneis, J. & Richardson, G. P. (2011). How small system dynamics models can help the public policy process. *System Dynamics Review*, 27: 22–44. doi: 10.1002/sdr.442
- Harich, J. (2010), Change resistance as the crux of the environmental sustainability problem. *System Dynamics Review*, 26: 35–72. doi: 10.1002/sdr.431
- Kalafatis S., Pollard M., East R. & Tsogas M. (1999). Green marketing and Ajzen's theory of planned behaviour: a cross-market examination, *Journal of Consumer Marketing*, 16(5), 5 pp. 441 – 460
- Meadows D. H., Randers J. & Meadows D. (2004). *The Limits to Growth: the 30-Year Update*. Chelsea Green: White River Junction, VT.
- Mola P.J. & Sonnenfeld D. A. (2000). Ecological modernization around the world: An introduction, *Environmental Politics*, 9(1), 1-14.
- Milaneza B. & Bührsa T. (2007). Marrying strands of ecological modernisation: A proposed framework, *Environmental Politics*, 16(4), 565-583.

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**Scientific Uncertainty and Environmental Justice: The Controversy  
over Water Resource Development in Taiwan**

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Abstract

How do issues of environmental justice play out in conditions of scientific uncertainty and cultural diversity? This paper use the case of the Tseng-Wen Reservoir Trans-basin Water Diversion Project in Taiwan to explore how policy stakeholders and local residents perceive the distribution of interests, the environmental risks of the project, and the policy implications of local action. The research methods adopted include documentary analysis and in-depth interviews. It shows multiple perspectives of stakeholders on the project, various knowledge claims among experts of different disciplines, and conflicts between local knowledge and experts. Environmental groups challenge the credibility of the environmental impact assessment (EIA). It highlights the problem of lack of recognition of people and place. The aboriginal tribe's unique cultural meanings, invisible cultural assets, and their integrated relationship with nature are excluded from the EIA report, which lacks fully informed consent and local residents' substantial participation in the decision-making process. The project involves scientific controversy as well as the unpredictable and irreversible impacts on the environment which cannot rely upon experts and technocracy only. Local particularities and lay knowledge need to be

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included in policy-making. This paper argues for the need of early involvement and public deliberation on water resource planning, and for seeking consensus through continuous intercultural and interdisciplinary dialogue.

Keywords: environmental justice, water resource governance, environmental risks, public participation, environmental impact assessment

## Introduction

Typhoon Morakot swept over Taiwan on August 8, 2009, pounding the nation with strong winds and downpours. The torrential rain triggered flooding in many areas and devastated the village of Siaolin in Kaohsiung County's Jiaxian Township, where around 500 people are thought to now be buried by mudslides. The affected local residents and environmental groups claim that the Tseng-Wen Reservoir Transbasin Water Diversion Project was responsible for the destruction of their villages.<sup>1</sup> Instead, the Water Resources Agency argues that landslides are caused by heavy rains and by local residents' improper land use, such as by planting ginger. The authorities and those advocates of the project argue that the project is crucial for effective water supply in southern Taiwan and for economic development. Local residents claim that their village got mudslides since the project began in 2004. Local environmental groups claim that the engineering design is not appropriate and that the long-term ecological impacts are difficult to predict. Local residents and environmental groups tend to think that the government's denial of the relationship between the project and the tragedy is unacceptable, and asked for an investigation committee to be established to determine the truth and to find out who are at fault for the tragedy.<sup>2</sup>

The Inter-basin Water Transfer Project raises important ethical and equity questions that include: "What is the risk of harm to the environment regarding the basin of origin from the loss of water resulting from the interbasin water transfer?" "Who will bear those costs?" and "Will those affected by the project have the opportunity to participate in the environmental impact assessment process and decision-making?" Environmental justice is a term that covers a wide range of issues and has many meanings to academia, environmental groups, and activists.

The Environmental Justice Movement emerged in the American context as a combination of environmental activism and civil rights advocacy, linking concerns

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<sup>1</sup> Taipei Times. MORAKOT: THE AFTERMATH: Victims blame reservoir project. Available at <http://www.taipeitimes.com/News/front/archives/2009/08/18/2003451435/print> (last accessed 2009/10/26).

<sup>2</sup> Taiwan Environmental Information Center. The village of Siaolin asks for the truth. <http://e-info.org.tw/node/48270> (last accessed 2009/10/26).

over environment, race, class, gender and social justice in an explicit framework (Taylor, 2000). Claims for justice made by environmental justice activists are more than about the just distribution of environmental goods and burdens. Efforts have been made to extend the analysis of justice in the distributive realm to issues of identity, (Peña, 2003; Ishiyama, 2003), recognition of difference, democratic procedures and greater participation (Schlosberg, 2004, 2007), the relationship between humanity and nature (Zerner, 2000), the connections between environmental justice and sustainable development (Agyeman & Evans, 2004), integrating the precautionary principle in research and policy-making (Morello-Frosch, et al., 2002), issues of environmental health (Shostak, 2004), and its intertwining with geography (Walker, 2010) .

The controversial Interbasin Water Transfer Project also involves scientific uncertainty and knowledge disputes among regulators, experts (e.g. geologists, ecologists, hydrologist and the civil and hydraulic engineers), environmental activists and local residents. Projects of transferring water from one river basin to another have the potential for serious ecological impacts, including changes in water quality and hydrologic regimes, alteration of habitat, and the introduction of non indigenous organisms. Research to date is inadequate for the assessment of water transfer impacts and site-specific ecological consequences (Meador, 1992). The precautionary principle has become an increasingly important theme in technological and environmental controversies in the face of scientific uncertainty. The precautionary principle prioritizes “prevention of harm and public health in the face of uncertain science and incomplete data” (Morello-Frosch et al., 2002: 62).

Environment concerns and risks need to be taken “in context” and knowledge should be regarded as a “process of sense-making within particular social and personal contexts (Irwin, 2001: 96,101). It is important to broaden the depth of current understandings of environmental justice issues and their complexity by exploring critically “the cultural dimensions of competing visions and struggles over citizenship, rights, and cultural identity in concrete situations.” (Zerner, 2000: 116). It is crucial to explore the practical experience of a community, especially the voices, knowledge claims, and perspectives of those involved in activism. This paper uses the case of the Tseng-Wen Reservoir Trans-basin Water Diversion Project in Taiwan to explore how issues of environmental justice play out in conditions of scientific uncertainty and cultural diversity. After both introducing the theoretical frameworks of environmental justice and sketching out the context of the development project, this paper explores how policy stakeholders and local residents perceive the distribution of interests, the environmental risks of the project, and the policy implications of local action.

## **Discourses on Environmental Justice and Precautions**

There are a variety of understandings about the conception of environmental justice from both activists and academics. The dominant way to think about questions of environmental justice is in terms of the fair or equitable distribution of environmental goods and bads. Concerns for the distributive dimension begin with the observation that people of colour, the poor, and indigenous tribes suffer from a disproportionate amount of environmental burdens. Many studies tend to focus on racial and income disparities regarding the distribution of environmental hazards. However, the sole focus on the distributive dimension of justice fails to reflect the multiple notions articulated by the environmental justice movement. Schlosberg (2007) argues that a theory and practice of environmental justice necessarily includes distributive conceptions of justice, but also embrace notions of justice based in recognition, capabilities, and participation. His pluralistic notion of environmental justice allows for the linkage between varied notions of just and unjust situations.

Demands for recognition and autonomy are evident and central to communities of indigenous peoples or ethnic minorities. As Taylor (2000: 534) argues, “the environmental discourses of people of color are framed around concepts like autonomy, self-determination, access to resources, fairness, justice, and civil and human rights.” He insists that autonomy is a major component of environmental justice and recognizes the need to “respect the cultures of all people, honoring cultural diversity, and appreciating a variety of belief systems that relate to the natural world” (p. 542). The lack of reflection on the impact of human conduct on nature would be at the heart of such domination and environmental justice problems. As to the issue of environmental destruction, nature could be seen as being subject to Fraser’s (1995: 71) three different forms of recognition: nonrecognition (being rendered invisible), disrespect (being routinely maligned or disparaged in stereotypic public and cultural representations) and cultural domination (being subjected to patterns of interpretation and communication). The discourse on environmental justice could extend recognition to nature and reflect on the relationship between humanity and nature. The recognition of nature entails our bringing nature’s signals into the decision-making process.

Schlosberg (2007) argues that fair procedure is a way to address both distribution and recognition. Shrader-Frechette (2002) provides the connection between the distributive and procedural dimensions of justice, and argues for a principle of *prima facie* political equality (PPFPE) as the basis for resolving and clarifying situations of environmental injustice. She argues that it requires integrating lay and expert knowledge with equal consideration to policy-making process surrounding the issue of a risky plant siting. Capek’s environmental justice frame also emphasizes citizens’

rights, democratic process and respect for grass-roots knowledge (1993: 8). The concerns with procedural equality in the environmental justice movement are actually linked to the call for justice in terms of recognition and the distribution of environmental risk.

In order to promote ethical consideration of scientific and technological developments, the United Nations Educational, Scientific and Cultural Organization also expatiates recommendations to its Member States on the Precautionary Principle. Precaution is regarded as an ethical responsibility and legal norm, and an important guiding principle in handling inevitable scientific uncertainty, especially in situations of potentially irreversible or catastrophic impacts (UNESCO, 2005). The Precautionary Principle challenges the authority of science, the manipulation of cost-benefit analysis by powerful vested interests, and the growing technicalities of environmental management at the expense of ethics and open dialogue (Jordan & O’Riordan, 1999: 16).

Research has shown how community-generated information and local knowledge can improve scientific inquiry and contribute to sustainable environmental decision-making (e.g. Van der Ploeg, 1993; Corburn, 2005). Democracy is an important component of precaution, and the deliberative process of public participation has been seen as a necessary element of the Precautionary Principle (Myers, 2006: 46). The Precautionary Principle argues that environmental decision-making in the face of uncertain data entails a transparent and democratic process to assess alternatives (Morello-Frosch et al., 2002: 61). In the report *Late Lessons from Early Warnings*, the European Environmental Agency suggests that policy-making needs to “take into account the wider social interests and values”. It states that “such broadening of the knowledge base can strengthen the appraisal, improve governance and democracy, and enhance the acceptability and legitimacy of the process” (Harremoes et al., 2001). Different local experiences could reflect the diverse understanding of the notion of justice and a variety of framing issues, which could shed important light on the conception of environmental justice.

## **The context and the research**

Instead of the traditional water basin planning, the current policy adopts “the overall joint deployment of regional water resources.” The Water Resources Agency, a subsidiary of the Ministry of Economic Affairs, cooperates with the National Comprehensive Development Plan and consults concurrently with various comprehensive development plans integrating the central, northern, southern, and eastern regions of all the counties and cities of Taiwan, and has subsequently drafted the “Water Resources Development Project of the Taiwan area” of 1999. It has



become the basis of the future water resource development until the year 2021. Inter-basin water transfer was thought of as one of major types of approaches for water resource development. According to the policy manual's matrix analysis evaluation, assessment results show that the Inter-basin Water Transfer Project only produced the negative environmental impact of environment and hydrology during engineering, but the existing construction technology should reduce the degree of disturbance during water quality construction, and even the local ecology can be restored after the completion of the project (Water Resources Agency, 2002). The government puts emphasis on the necessity for developing the Inter-basin Water Transfer Project (Water Resources Agency, 2002).

The Water Resources Agency pointed out the growing demand for public use of water in the southern region, and decided to give priority to promoting it after evaluating alternative projects, because the Tseng-Wen Reservoir Inter-basin Water Transfer Project has the benefits of "lower original water cost, and less impact on the environment." The Tseng-Wen Reservoir Inter-basin Water Transfer Project passed the first phase of the EIA in July 1999, and completed the second phase of the EIA conditionally in May 2002. The Executive Yuan approved the project in April 2003, and is scheduled for completion in 2012. It is expected to increase the water supply capacity to 600,000 tons per day.

The project spans across Taoyuan, Namashia, and Liouguei Township in Kaohsiung County, Tainan County, and Chiayi County. The project is located mostly at mountain reservations and the majority residents are the Aborigines. Most of them are of the Bunun tribe. There are also some Han Chinese, the Tsou tribe, the Paiwan tribe, and the Daman tribe of Pingpu Siraya. Most of Aboriginal townships' residents are Christian. The population structure of the townships in which the water diversion projects passed were mostly elderly and work on agriculture. Due to the limit of traffic and geographical conditions, local livelihoods still rely on traditional sloping agriculture.

The research methods adopted are documentary analysis and in-depth interviews. Policy stakeholders and actors of the Tseng-Wen Reservoir water diversion project were selected for interviews, including elected officials, environmental groups, experts and local residents. Since the development project involves multi-disciplinary expertise and scientific disputes, the expert interviewees include experts and scholars of difference areas (e.g. ecology, geology, engineering, law, medicine). The snowball sampling was used to find other available information and differing perspectives of the interviewers. Interviews were conducted from September 2010 to July 2011.

## **Distribution of benefits and risks, and the controversy over the EIA**

Policy stakeholders take a different view regarding the fairness of distribution of benefits and risks of the Inter-basin Water Transfer Project. After a discussion on the controversy of water supply and demand, along with competing views on the necessity of the project and economic efficiency, a discussion has developed on the controversial environmental impact assessment and local environmental risk perception.

### ***Dispute over water supply and demand, and who benefits***

The government tends to regard the Inter-basin Water Transfer Project as an issue involving both the southern regional water supply and economic development, and emphasizes the increasing water demand in Taiwan. The Water Resources Agency argues that the southern area's domestic and industrial water supply and demand estimated use is reasonable. Instead, environmental groups tend to think that water demand will decrease in the future, however. The Water Resources Agency pointed out the problem with current laws, and the existing Water Act needs to reflect the change in the water supply plans of the industrial areas. After amending the law, the government could shift the previously approved water supply quantity that does not develop as well as expected from the southern industrial areas to other new industrial areas, and then it might be able to reduce the demand for water. However, the Chiayi County, Tainan County, and Kaohsiung County governments have new development plans and water demands. According to the Water Resources Agency, the question of whether or not the water demand can be decreased depends on both the individual county and the city governments' policies. The government has further emphasized the trend that urban water usage is proportional to the GDP in the world, and sufficient water resources will be "the key to the Kaohsiung economic development" (Lin, 2006).

The argument of the Water Resources Agency for water supply and demand is questioned by some scholars, experts, and NGOs. The Water Resources Agency's estimation of water demand in the southern area has been based on the White Paper of the water resources policy of 1996, but the structure of supply and demand has significantly changed. In 2006, for example, the maximum daily demand was 3070 thousand tons per day, below the White Paper of water resources' low growth estimate. In addition, the Water Resources Agency used the population growth as the basis for the estimation of domestic water growth usage, but the population growth rate declined in Taiwan. This seems to show an over-estimation of the demand for water, and the estimation of personal water consumption's high growth seems to be opposite to that of the "water conservation" policy. As to the southern industrial water

demand, the Water Resources Agency estimated that the growth of industrial water usage to have "very high growth", and the water demand will increase to an additional 700 thousand tons per day in 2021 from that of 2006. But the agency did not provide detailed information on how to calculate the water demand (Lu, 2006).

One interviewed expert has questioned the legitimacy of the Inter-basin Water Transfer Project: "Is the project's aim actually for the Southern Taiwan Science Park's water demand? The government did not tell the real purpose and they are always so secretive" (Experts Z). The southern area's water supply structure has also been questioned. Lu (2006) questioned the Water Resource Agency's inclusion of not only the official water supply capacity data from the south (3670 thousand tons per day), but also whether this data should be re-estimated to avoid the waste of water resources management, whether it should improve the leakage rate, and whether it should offer the long-term pipe replacement project to reduce the water supply's loss ratio.

In order to maximize the effectiveness of the regional water resources supply, the agency promotes the Water Diversion Project that transfers the Laonong River's surplus water in the wet period (from May to October)—the tributary of the Gaoping River, to the reservoir of the Tseng-Wen River. The Water Resources Agency pointed out that the southern area has the problem of "rain or dry polarization"; that the heavy rain or drought will increase in the future. If water resources are not developed appropriately, the water supply will not be stable, and the agency has concluded that the Inter-basin Water Transfer Project can take advantage of existing facilities without the additional construction of reservoirs." The agency put emphasis on "only the construction of the low weir and tunnels, with a small impact on the environment," "low cost," and on the southern area's increase of 600 thousand million tons per day in water supply after the completion of the project, expecting to contribute to mid-term and long-term water demand usage in the future (Lai, 2006).

Lu (2006) has highlighted the trend that the rainy season's rainfall has increased in recent years, resulting in the Tseng-Wen Reservoir to become full and flooded, has advocated that all of the analysis data of rainfall and climate should be re-evaluated, and that the government should provide the rainfall forecasts to convince the public. Now the Kaohsiung area's water supply comes from the Gaoping Weir and the water treatment plant in the summer, while the water from the Chia-Sheng Weir to the Nanhua Reservoir provides supply in the winter. However, the Gaoping Weir's upstream and downstream are often overwhelmed by silt during the heavy rainfall, resulting in turbidity and the paradox of "heavy rain but no water available for use." Interviewed experts questioned whether the diversion project corresponds with economic effectiveness

The water diversion project has also involved the issue of budget exclusion. Local environmental NGOs think that limited budgets should be spent on forest protection and soil and water conservation, rather than concentrating its resources on constructing reservoirs and water diversion projects, and they questioned whether behind this project there are huge interests and profits for a few people:

The engineering and public sector are conspired, ...and they rationalize that the metropolitan and industrial areas need water! ...So we have planned a variety of large-scale projects. (Interviewer P)

### ***The EIA's apprehensions and the risk perception in the local environment***

The Diversion Project has caused considerable controversy over the geological, hydrological, and ecological impacts. The Tseng-Wen Reservoir Water Diversion Project construction area passed through a number of fault zones and folding structures; such geological conditions leading to problems of confrontation with the fracture zone between the east and west tunnel, rock extrusion, stabilization of the slope of entrance, gushing water, and gas emissions. Even more, the East Tunnel has encountered the geothermal problem due to the flow of water through the groundwater veins of the hot springs in the Shao-nian river. Problems have arisen from its geological conditions, from the first phase of the EIA, and continuing queries have been posed from the scope-determination meeting, site-inspection briefings, hearings, group meetings, the review committee, academic experts, and relevant institutions. Nevertheless, the developmental organization has considered that the fault through which the tunnel passed is not an active one, that the existing engineering technology can overcome the problem, and that the tunnel's geological assessment had completed. However, according to the policy of the EIA report for reducing the environmental impacts during the construction period, it was mentioned that "... there are incompetences in this geological tunnel survey, so that the construction plan will be programmed for seismic or drill tests if necessary in order to understand in advance the geological status for excavation" (Water Resources Agency, 2003). The "incompetence of the geological tunnel survey" mentioned in the EIA report highlights the "unpredictable" impacts of geological problems. Can security or safety be guaranteed as the developmental organization replied in the EIA process? The construction work might encounter unknown risks and cause a possible unrecoverable negative impact.

Some ecologists believe that the diversion project poses a high degree of risk, and they stress learning from the blind spot of past geo-engineering. For example, the 12.9 km-length Xue-shan freeway tunnel had experienced a fracture zone and gushing

groundwater during its construction, the excavation resulted in a significant flow reduction in the Fei-cui reservoir and has led to unprecedented water shortages in Pinglin of Taipei County and Ilan County. The National Engineering Bureau has admitted that water gushing up at the east entrance was mixed with surface water poured from 1953, while the west side belongs to deep "ancient groundwater" being attributed to around eight thousand to twenty thousand years ago. On December 16, 1979, a sudden water gush of 700-800 liters/per second inside the westbound area completely destroyed the drilling equipment, and subsequent works had to take the traditional hand-digging and drilling method. In addition, there is the other case of the Chungliao Tunnel. When it was launched in 2000, the major water source at the Chungliao community in Qishan town Kaohsiung County declined drastically and even became drought. Residents petitioned it for many years, and the condition was finally confirmed relevant by monitoring of the Kaohsiung City Civil Technicians Association in 2006, which forced the National Engineering Bureau to spend seventy million NT dollars in the placement of water supply facilities to solve local water problems. The tunnel length of the Tseng-Wen Reservoir Water Diversion Project is longer than the Xue-shan freeway, causing great concerns about damages in the groundwater vein (Li, 2006).

Whether or not the tunnel explosive work affects the local geology has also been questioned. Simultaneous monitoring of vibration and noise was proceeded by the construction unit during its tunnel explosive drilling work from October 26 to 29, 2007 in Qin-he, Minzu village, yet no significant differences were noted compared to the monitoring results during the tunnel bombing and the customary time without bombing. In addition, the monitoring results were only presented by volume comparative tables (Water Resources Agency, 2009). However, due to the fragile geology and the varied features of the region, the consequences yielded by minor differences in drilling impact or vibration caused by explosive work are not indisputable, because it involves the precision of instruments, test sites and methods, implications of data, and so on. Environmental groups repeatedly stressed that with construction in an environmentally sensitive and geologically vulnerable region, the dangers of the water diversion project is hard to predict and measure:

The risk is so high, the Nanzih mountains are so fragile, and the underground hot springs have been destroyed ... it was a big artery of earth. We know that water is very gentle, so where did it burst out? If you see a spout of water in the ground, it's harmless, but what if it's inside the mountains? (Environmental groups)

As to the local hydrological and ecological impacts, the water diversion project draws from the Laonong stream by the weir in the wet period. The original impact assessment has focused mainly on whether the flow is able to meet the demand of the downstream region. In general, the effluence after the weir water-extraction is required to maintain at least the basic flow of the downstream river and registration requirements of the water claim. In this regard, the developmental organization assumed that there had been no substantial influence on the river flow during construction (Water Resources Agency, 2003), and even though the flow would slightly decline, they promised that there would be no effects on water rights, ecology, or river leakage in the downstream area (Water Resources Agency, 2003).

The flow quantity of the Water Diversion Project and its impact has also been questioned. The Water Resources Agency claimed that the drawing volume of this water diversion project only accounted for 2.7% of the Kao-Ping River Basin in the wet period, and they announced that it will have a minimal impact. But the actual drawing volume amount of 225.07 million tons accounted for 22.4% of the Laonong stream in the wet period, equivalent to about a quarter of its flow. The EIA committee queried for the affected amount of the Laonong stream, but the construction units insisted that the amount still met the flow standard. Even so, ecologists and environmental groups worried that the consequences are bound to affect the boating and tourism industries and impact the local ecology (Li, 2006).

Whether or not the Laonong Weir and its east tunnel excavation might cause a negative impact on the nearby hot springs and the local Shao-nian creek tourism resources has lead to considerable controversy. In response to the residents' apprehension, the construction unit assumed that it may cause a short-term water shortage during its excavation, and the Shao-nian River Scenic Hot Springs Area had been therefore coordinated for a suspended opening during the construction period in order to reduce the impact, and when the excavation will have completed its first lining, the groundwater will gradually resume to its normal condition (Water Resources Agency, 2003). The Tsengwen reservoir construction work will take more than a decade, and the construction duration of its east tunnel and weir is not mentioned in the EIA report; in such a case, the practice of closing down the spring area will impact the rights of local residents and their livelihoods and tourism resources. The tourism industry in Liou-guei and Bora relies on geothermal hot springs, and local residents are concerned that the excavation will result in changing the underground tunnels of the hot spring, drying up the source, and thus ruining the Liou-guei tourist industry. Residents of the respondents pointed out that the negative impact has been quite significant after the construction launched:

Before they started their work, there had been a Shao-nian creek hot spring spot, but after they started, in less than two weeks the whole creek had dried up. Newspapers have reported the incident, and it also has an impact on the hydrology. Farmers are well-aware of that, and they can immediately sense the difference. (Residents L)

One well-known ecologist presumes that the water diversion project will lead to a "fundamental, significant change" in different hydrological regions. Climate change and biological evolution in Taiwan has entered its upheaval period, and this development plan will synergize all devastating effects. In addition, after the completion of this diversion program, the three major river systems in southwestern Taiwan will all be drying headward rivers, which will cause an overall unrecoverable impact on the topography and hydrology of the downstream regional ecology (Li, 2006). Furthermore, in the Shao-nian River Scenic Area near the eastern tunnel severe landslide occurred in the Laonung river after heavy rainfall, but the EIA report did not assess this impact. Typhoon Morakot had caused major geographical landscape changes and ecological impacts in the vicinity of the diversion project, and also highlighted the vulnerability of the local geological and hydrological environment, as well as the unpredictable character of Nature.

### **Struggle for recognition of difference: cultural continuity and local identity**

Controversies over the Water Diversion Project and the conflicts of homeland reconstruction, as well as issues of accountability, or who was responsible for the disaster caused by the Morakot typhoon, highlight the problem of lack of recognition of difference. The problem of misrecognition involves not only differences in the "people" but also in the "locality". Local residents think that the Water Diversion Project designated at the indigenous tribal area displays its irreverence:

We feel that we are the scapegoat for the suspension of the Meinung Reservoir, and this shows high disrespect. Such major governmental construction projects over the mountains display irreverence for the indigenous people. Anyway, they are just taking advantage of the indigenous people...and we are tantamount to be as a scapegoat. (Resident L)

There is a great gap and difference between the government agency and the local residents' assessment or judgment of the project. The appraisal item for "cultural and

folk activities” in the EIA report mentioned the local significant annual ritual activities of Bunun and Tsou and that the construction site is not located in the aboriginal cultural events venue; despite that the works will change the environment of the terrain, topography, and vegetation, and it will not affect local cultural activities and folklore (Water Resources Agency, 2003). It seems to be briefly and casually described in the text of EIA report.

The EIA report did not mention the assessment impact of the intangible cultural assets, which excluded certain special symbolic meanings for the local indigenous people, such as the headspring of this project, the Laonung River, which has been regarded as the mother river by the local Bunun tribe. Representatives, the village head, the church pastor and opinion leaders from Taoyuan Township announced the establishment of the "anti-Laonung Water Diversion Action Coalition" on March 16, 2004, and they stressed the declaration of: "maintaining the ecological environment at the Laonung river, safeguarding the habitat of indigenous ancestors, and ensuring the survival rights of future generations." The construction project which was planned to tunnel through the Central Mountain Range undermines its "ancestral spirits" and could be regarded as disrespect for the sacred space of local residents.

Official and engineering experts tend to endow nature and earth with pecuniary value, and water resources with monetization. Nature is regarded as merely “stuff” composed of materials rather than something which has any intrinsic meaning and sanctity (Xiao, 2009). The delegate of the Bunun tribe in Taoyuan Township drew attention to the actions of the Water Resources Agency when they protested against the Ministry of Economic Affairs in June 2004, for proceeding with a land levy on Aboriginal land in Laonong without holding any prior public hearing or efforts of coordination. The government enforced a very cheap levy on the land, without regard for the dignity and rights of the indigenous people. Local environmentalists deemed that water transfer would change the landscape within the next million years, which is a decision that “takes the place of God.” The “holistic water” perspective should therefore be adopted.

These water officials are either experts in reservoirs or engineering in that they recognize water simply as a kind of resource, but never understand that it is the source of ecology, earth arteries, and the sole nourishment of the creatures. Water is the mother of ecology, and neither plants nor animals can live without it. But in their eyes, the water resource is for reservoirs and industrial use, and both of these demand construction. But if we expand upon the concept of water, then it will return to the mechanism of its own natural cycle. “The forest is a natural reservoir if you would take good care of it, is not for reclamation, is clean, and is a green sponge that will provide you with an unfailing supply” (Interviewee, G1).



Local residents have laid claim to the significant negative impact on the local environment after the project started in 2004, and have questioned the connection between the diversion works and the devastation of Siaolin village in Kaohsiung County. Environmental groups were suspicious of the doubtful points between the diversion project and the village-elimination, suspecting that the project was the main cause of this tragedy, but the Water Resources Agency believed that it was caused by heavy rainfall, that is, by the “natural disaster.” According to the investigation and report, “The key 110 seconds of the Siandu Mountain landslide,” led by Professor Chen Hongyu from Department of Geology at the National Taiwan University, dip slope and fragile geology were the basic conditions that caused the mountain slide of Siandu and the elimination of Siaolin village, and heavy rainfall was the external force and the last straw. Local fragile geological conditions such as dip slopes, well-developed faults and joints, and imbedded shale were the fundamental causes of the mountain slide.

After a one-year investigation, the Kaohsiung District Prosecutors Office declared the investigation to be closed in August of 2010, concluding that the elimination of the Siaolin village was caused by natural disasters, not human negligence. One engineering expert commented on the statement of construction causation, and considered that in accordance with investigation result, there was no evidence for a causation between the diversion project and the elimination of Siaolin village, and had emphasized that any inference should be based on "sufficient evidence" (Interviewee Expert W).

The survey completed by geology and engineering experts is not indisputable; other experts had put forward different opinions. Some experts interviewed pointed to the problem of lack of in-depth understanding of the local situation. Considering the mountain slide near the construction area and the more serious destruction in the neighboring villages, it is difficult to believe that there could have been an irrelevant relationship between the diversion project and this disaster. But there are difficulties in proving the causal relationship:

This is the upstream area of the inter-basin water transfer area, the “Butangbunas Creek,” which means “muddy water” in the aboriginal language. Those who map out the water transfer project from this muddy river have no idea about the environment; they just draw on the map and do whatever they decide to do anyway (Interviewee, Expert H).

The typhoon Morakot is definitely the reason for the elimination of the Siaolin village, but what about the inter-basin water transfer construction works -

including the mountain demolition and accumulation of riverbed rocks from the back? Could they have also exacerbated the disaster? We must see whether these downstream areas of the three rivers that the diversion works passed through had seriously been affected by the storm. As a matter of fact, they were. “At least the flood as well as the mountain demolition with debris dug out had surely affected the surrounding collapse” (Interviewee, Expert Z).

Even though the local residents had found that the argument by the Kaohsiung District Prosecutors Office and scholars - who had claimed that the mountain demolition of the diversion project was totally irrelevant to the collapse in Siaolin - to be implausible, they were unable to challenge the authorities on scientific claims, which highlights the problem of uneven resources:

But historically, why hadn't heavy rainfall previously resulted in as big of a disaster as there had been in 2004 and 1996, which had had an equivalent amount of heavy rain? There had been explosions proceeding the construction, and they said it didn't cause a dramatic impact. “Although we were unable to present specific data, it seemed as if something was wrong- as if by instinct”(Interviewee, Aboriginal Respondent L).

There were people who laid the blame on local residents for their improper land-use that caused land losses by floods (e.g. planting shallow-rooted crops such as ginger), or even blamed the aboriginal people for the destruction of the forests. The interviewed aboriginal residents stressed their harmonious relationship with nature, and they assumed that the speculation and doubt from outsiders stigmatized them for these matters:

The aboriginals never waste natural resources due to their respect for the land. Even with an abundance of possessions, they would only consume what they really need. The concept of trading was built by their contact with the Han [Chinese]. Aaboriginals were unable to do extensive hunting or planting some highly-profitable crops. (Interviewee, A4)

The local residents point out the false forest policy and inducements to the aboriginals:

About four or five years ago, the Forest Bureau was promoting a forest policy that offered a subsidy of 500 thousand dollars for a 10 thousand

square meter forest-plantation, paid in installments over ten years. As a result, the aborigines cut down the original forests in order to plant new ones. Some unscrupulous businessmen incited the aborigines and tempted these innocent people to endorse on their behalf. (Interviewee, A1)

### **Lack of democratic participation and informed consent**

The water diversion project lacked substantive local participation, which only had the formality of a single-way communication or propaganda and lacked of adequate informed consent with the residents. Although public hearings were processed at the time, it seems merely a formality of public meeting instead of seeking consensus through comprehensive community participation and social assessment.

The Water Resources Agency was inclined to presume a “deficit model” for the public understanding of science or their attitudes toward water resources development. In the “social relations” item of its EIA, the EIA report stated that the “psychological shock” of local residents was mainly “by doubts due to unfamiliarity with the content of this project,” and it was supposed to enhance public understanding and to reduce its psychological impact through activities such as the tour at Jiasian Weir for local residents (Water Resources Agency, 2003). The EIA report failed to show the complexity of public risk perception and judgment, and the developmental organization seemed to overlook the social and cultural rationality of local residents and the importance of democratic participation in science and technology in the at-risk society. The Water Resources Agency held an EIA briefing of the project in 2000 in the Taoyuan Town Hall, where the mayor of Taoyuan Township, the County councilor, delegates and chiefs from the Jianshan and Fuxing villages, along with more than one hundred villagers attended, and these participants have expressed disagreement in the project. However, the project still passed the EIA process in 2003, which caused a local resident demonstration. Local residents’ appeals was that the government should communicate and consult correspondingly with reciprocal sincerity, and fully inform local residents of any possible negative impacts on them during the period of construction, particularly in relation to land use and water resources acquisition.

The Water Diversion Project had three EIA content revisions. The original weir was washed away due to the typhoon in 2009; therefore, the Water Resources Agency redesigned it, adding new access for subterranean drainage and removing additional facilities to the opposite bank. Yet, the revision was rejected by the EIA Committee after environmental differentiation analysis. However, the Water Resources Agency continued the development and said as its excuse that the construction had been contracted out. It manifests the incomprehensive process of the site-selection process

and the problem that the affected residents are still being excluded from the EIA and decision-making process.

Local aboriginals tried to block the weir construction to express their opposition and asked the government to value their opinion. Twice the villagers reported suspicious land denudation by construction workers, but the contractor presumed that local action had affected the construction progress, who filed a suit against 7 aboriginals and claimed 12 million NT dollars. The villagers' obstruction incurred recompense claim: "some of our key members became the Namasia Township defendant because of the obstruction; they were accused by the Water Resources Agency and contractor and claimed compensation" (Interviewee, Resident L). Instead of arousing further "public disobedience" support, villagers became timid due to the lawsuit. This also highlights the socially-disadvantaged aboriginals' predicament that they were unable to fight with governmental authority and business interests.

Many scholars and experts, NGOs and local politicians have proposed alternatives to the controversial Water Diversion Project, such as an amendment to the Kaohsiung-Pingtung Great Lakes Plan, improvement to the water-acquisition of Kaoping Weir, review of water-demand of household. However, the Executive Yuan responded that the engineering contract had been approved. The government and engineering experts ignored local particularity and excluded other alternatives owing to their preconceived ideas formed by professional training:

The frequencies of landslides in Taiwan are much more than in the U.S., but the experts calculated based on the U.S. standards. The water-acquisition measure is not applicable to terrain in Taiwan ... The river course is marked by vicissitude; what we gain instead of water, is sand (Interviewee, Expert L)

Many interviewed experts questioned whether the policy option seems to be the decided one; the current feasibility assessment is only a formality, and the selecting program has not been a detailed rating.

Morakot typhoon had severely damaged the construction area of the Tseng-Wen Reservoir Water Diversion Project, the Executive Yuan approved to "maintain a suspended state" in September 2009, and the first phase of five-year program of monitoring was ratified in 2010, which included disaster prevention and safety measures, monitoring of watershed environment, etc. Even though the hurricane suspended the project; the government did not give up the water diversion project. The Agency also stressed that the construction work is scheduled for the Southern water demand (Water Resources Agency, 2010). Since the hurricane had caused significant changes in the terrain and environment, the unfinished tunnel lost its

water-acquisition function due to its displacement. Interviewed experts describe the currently suspended construction work by an analogy with "interrupted-performance operation", and it would bring the risk of collapse if further construction work was failed to be adopted. he also admitted that the resumption assessment involves political factors (Interviewee, Expert W). The current government decision-making relies on experts and political considerations. However, such a significant and far-reaching policy really needs to be incorporated with substantial resident participation and interdisciplinary assessment.

## **Conclusion**

This research presents the unequal power relationship between the aboriginal minority and the state. The problem of unfair distribution of interests and risk, lack of recognition of cultural difference, local knowledge and ways of seeing, and exclusion from the decision-making processes are interwoven. It also highlights distrust of laypeople to experts, and the conflict and confrontation among experts in differing disciplines. Competing risk perception and judgment involves scientific debates, and also reflects the cultural and value differences, the local aboriginal's interrelated relationship with nature, the special connection with the land and local identity, and the idea of the good life. However, the current political and economic structure is development-oriented. The government's decision-making tends to adopt the economic and technical approach, and fails to fully disclose complete policy information. Environmental impact assessment emphasizes the profession of engineering and the status of biophysical, while the social and cultural impact or other intangible aspects have been either marginalized or not evaluated.

This case presents many problems with the current decision-making on water resource development. The Inter-basin Water Transfer Diversion Project involves scientific debates and the unpredictable impact on the local environment. Decision-making can not merely rely on experts and technical opinion, and local particularities and lay knowledge should be incorporated. These issues highlight the importance of water resources governance with socially and environmentally sensitivity as well as the institutionalization of citizen participation. The shortcomings of the current EIA system have caused considerable controversy in many development projects. In addition to strengthening citizen participation in the EIA phase, it is important to pay more attention to the interests of affected residents. They need to expand community participation in its early stages of future policy planning and promote public deliberation, and seek consensus on controversial issues (e.g. the adjustment of industrial structure, allocation of water resources, the necessity of developing new water resources and alternatives) through intercultural and

interdisciplinary dialogue. Water resource development as well as water supply and demand involves issues of regional and intergenerational justice. Water resources development must be compatible with the overall planning of land use and comprehensive assessment. It also requires financial investment for a long term investigation and research. Finally, it needs to strengthen accountability mechanisms, and to avoid rapid change or uncertainty in the socio-economic and natural environment which may deteriorate the problems of environmental injustices.

## References

- Agyeman, J. & Evans, B. (2004) "'Just Sustainability': the emerging discourse of environmental justice in Britain?" *The Geographical Journal*, 170, 2: 155-64.
- Capek, S. (1993). The "Environmental Justice" Frame: A Conceptual Discussion and an Application. *Social Problems*, 40 (1): 5-24.
- Corburn, J. (2005). *Street Science: Community Knowledge and Environmental Health Justice*. Cambridge, MA: MIT Press.
- Fraser, N. (1995). From redistribution to recognition? Dilemmas of justice in a 'postsocialist' age. *New Left Review*, 212: 68-93.
- Harremoes, P. et al. (2001). *Late Lessons from Early Warnings: The Precautionary Principle 1896-2000*. Copenhagen: European Environment Agency.
- Irwin, A. (2005). *Sociology and the Environment*. Cambridge: Polity.
- Ishiyama, N. (2003). Environmental Justice and American Indian tribal sovereignty: Case study of a land-use conflict in Skull Valley, Utah. *Antipode*, 35: 119-139.
- Lai, C. H. (2006). The Introduction of the Project. Symposium on the Tseng-Wen Reservoir Inter-basin Water Tansfer Project. Kaohsiung County: Kaohsiung County Government. (In Chinese)
- Li, K. C. (2006). The ecological dimension of the Project. Symposium on the Tseng-Wen Reservoir Inter-basin Water Tansfer Project. Kaohsiung County: Kaohsiung County Government. (In Chinese)
- Lin, L. S. (2006). The demand and supply dimension of the Project. Symposium on the Tseng-Wen Reservoir Inter-basin Water Tansfer Project. Kaohsiung County: Kaohsiung County Government. (In Chinese)
- Lu, T. Y. (2006). The water demand and supply dimension of the Project. Symposium on the Tseng-Wen Reservoir Inter-basin Water Tansfer Project. Kaohsiung County: Kaohsiung County Government. (In Chinese)
- Meador, M. R. (1992). Inter-basin Water Transfer: Ecological Concerns. *Fisheries*, 17: 17-22.
- Morello-Frosch, R., Pastor, M. & Sadd, J. (2002). Integrating Environmental Justice

- and the Precautionary Principle in Research and Policy-Making: The Case of Ambient Air Toxics Exposures and Health Risks among School Children in Los Angeles. *Annals of the American Academy of Political and Social Science*, 584: 47-68.
- Myers, N. (2006) Precautionary Procedures: Tools of Analysis and Intention. In Myers, N and Raffensperger, C (eds.) *Precautionary Tools for Reshaping Environmental Policy*. Cambridge, Mass.: The MIT Press.
- O’Riordan, T. and Jordan, A. (1995). The Precautionary Principle in Contemporary Environmental Politics. *Environmental Values*, 4: 191-212.
- Peña, D. (2003). Identity, Place and Communities of Resistance. In J. Agyeman, R. Bullard and B. Evans (eds.) *Just Sustainabilities: Development in an Unequal World*. London: Earthscan.
- Schlosberg, D. (2004). Reconceiving Environmental Justice: Global Movements and Political Theories, *Environmental Politics* .13(3):517-540.
- Schlosberg, D. (2007). Defining Environmental Justice: Theories, Movements and Nature. Oxford: Oxford University Press.
- Shostak, S. (2004). Environmental Justice and Genomics: Acting on the Futures of Environmental Health. *Science as Culture*, 13(4): 539-562.
- Shrader-Frechete, K. (2002). *Environmental Justice: Creating Equity, Reclaiming Democracy*. Oxford: Oxford University.
- Taylor, D. (2000). The Rise of the Environmental Justice Paradigm: Injustice Framing and the Social Construction of Environmental Discourses. *American Behavioral Scientist*, 43 (4): 508-80.
- UNESCO, (2005). *The Precautionary Principle*. World Commission on the Ethics of Scientific Knowledge and Technology, UNESCO, Paris. Available at: <http://unesdoc.unesco.org/images/0013/001395/139578e.pdf> (last accessed 10 November 2009).
- Van der Ploeg, J. D. (1993). Potatoes and knowledge. In M. Hobart (ed.) *An Anthropological Critique of Development: the Growth of Ignorance*. London: Routledge.
- Walker, G. (2010). Beyond distribution and proximity: exploring the multiple spatialities of environmental justice. In R. Holifield, M. Porter and G. Walker (eds.) *Spaces of Environmental Justice*. Oxford: Wiley-Blackwell. pp.1-22
- Water Resources Agency (2002). Water resources development plan in Taiwan. Taipei: Water Resources Agency, Ministry of Economic Affairs. (In Chinese)
- (2003) The environmental impact assessment report of the Tseng-Wen Reservoir Transbasin Diversion. Taipei: Water Resources Agency, Ministry of Economic Affairs. (In Chinese)

- ( 2009 ) Tseng-Wen Reservoir Transbasin Diversion: report of the analysis of the difference of the environmental impact assessment, Taipei: Water Resources Agency, Ministry of Economic Affairs. (In Chinese)
  - ( 2010 ) Tseng-Wen Reservoir Transbasin Diversion: table of the third correction of environmental impact assessment. Taipei: Water Resources Agency, Ministry of Economic Affairs. (In Chinese)
- Yeh, F. C. (2010). Challenges and Constrains of Practice of SIA: Experiences form Austrian and Hong Kong. Workshop on Social Impact Assessment and Social Development, Taipei County: National Taiwan University (In Chinese)
- Zerner, C. (ed.) (2000). *People, Plants, and Justice: The Politics of Nature Conservation*. New York: Columbia University.



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**Track 1c**

**Beyond ‘sustainability’: (re-)defining and institutionalisation of sustainability**

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***Title: What Happened, Eh? Canada’s (In)ability to Meaningfully Institutionalize Sustainable Development, 1987-2012***

**Extended Abstract**

Over the past two decades, the concept of sustainable development has become a popular policy goal, with the result that many wealthy countries have undertaken “initiatives to integrate the consideration of environmental issues into development decision making” (Meadowcroft & Bregha, 2009, p. 7). The political climate in Canada was greatly influenced by events leading up to, and the publication of, the 1987 World Commission on Environment and Development (WCED) report *Our Common Future* (Smallwood, 2009). The federal government’s embrace of the sustainable development agenda in the late 1980s and early 1990s, as demonstrated through numerous public consultation initiatives and the release of its 1990 *Green Plan*, made the country a leader on the global sustainable development scene; 20 years later, Canada has earned a reputation as an obstructionist player in international environmental negotiations, and has failed to enact and enforce effective federal sustainable development legislation. The situation is nicely summarized by Toner & Meadowcroft (2009): “since 1987, various Canadian federal governments have formally committed to this transformation by introducing sustainable development policies, institutions, and practices. Indeed, in the 1990s Canada was considered an innovator and leader in this ‘change process’. Few would say this is the case today” (p. 78).

The anticipation of the 2012 United Nations Conference on Sustainable Development (UNCSD, or, Rio +20), provides an interesting political moment to reflect on the progress – or inability – of the Canadian government in achieving its own sustainable development goals over the last 25 years. Presently, the federal government does not appear to have sustainable development anywhere on its political agenda: “the Harper government is currently experiencing a degree of cognitive dissonance between what it knows are the expectations of Canadians for innovative solutions to address climate change and other SD issues, and what it has delivered to date” (Toner & Bregha, 2009, p. 45). The past year in particular has seen a steady erosion of sustainable development and environmental policy, programs, advocacy, and priorities, coupled with an attempt by the government to de-legitimize environmental non-governmental organization (ENGO) perspectives. If the 2012 federal budget is any indication, it seems that this government’s neoliberal agenda includes rolling back of environmental research and regulation as part of its plan to reduce the role of big government while encouraging private sector innovation and economic generation.

In the wake of recent actions that will have devastating repercussions for sustainable development policy and governance in the country – such as the announcement in December 2011 that Canada will withdraw from the Kyoto Protocol and the severe cuts to environmental monitoring and protection proposed in the March 2012 federal budget – this paper presentation analyses the dominant discourse and effectiveness of institutionalization of sustainable development policy between 1987 and 2012. To awaken public awareness of the weakness – and ongoing erosion – of existing sustainable development policy mechanisms, the research examines three initiatives developed by different political administrations for their (in)ability to meaningfully institutionalize sustainable development: the 1989 establishment of the National

Round Table on Environment and Economy; the 1995 creation of the position of Commissioner on Environment and Sustainable Development; and, the 2010 introduction of the recent Federal Sustainable Development Strategy.

The analysis sheds light on the way that sustainable development has been defined by the federal government so that it is mainly dealt with through piecemeal, incremental, or backward-facing approaches. The outcomes of this research, undertaken through a literature review, scan of policy documents, websites, and news items, suggest that effective institutionalization of sustainable development policy has not occurred in the Canadian federal context. Notably, the findings indicate that there is a lack of multi-jurisdictional and horizontal coordination; the policies are not lead by key, influential, high-level federal departments; and, there is not equal integration of environmental considerations in decision-making.

Traditionally, the role of government is to “monitor changes and threats to the environment, raise public awareness, set societal goals, create patterns of incentives for firms and individuals, and invest in analytical and management tools to reduce adverse impacts, remediate problems, and prevent future ones” (Toner & Bregha, 2009). In Canada, there have been a number of regulatory, voluntary and economic initiatives over the past two decades attempting to institutionalize sustainable development (Toner & Bregha, 2009), with some attempts exhibiting more success than others.

The 1987 WCED report *Our Common Future* provided the most popularly cited contemporary definition of sustainable development as “development that meets the needs of the present generation without compromising the ability of future generations to meet their needs” (World Commission on Environment and Sustainable Development, 1987, online). Within

expanded definitions, the goals of sustainable development are presented as a number of interlocking concerns – the need to balance environment, economy and social considerations in decision-making (Wheeler, 2004). For these reasons, sustainable development is sometimes “best understood as an emergent international norm that denotes a specific kind of development trajectory. It is associated with important values such as the promotion of human welfare, the preservation of ecosystems, inter- and intra-generational equity, and public participation in development decision making” (Meadowcroft & Bregha, 2009, p. 2). If we are to succeed in these goals, our current government institutions which have been developed over centuries must now adapt to changing conditions in order to effectively address emerging, complex challenges (Meadowcroft & Bregha, 2009).

From the mid-1980s to early 1990s, Canada was a leading country promoting sustainable development (Runnalls, 2009; Toner & Bregha, 2009; Tarasofsky, 2007). After meeting with the Brundtland Commission in 1986, the Canadian Council of Resource and Environmental Ministers (CCREM) developed a National Task Force on Environment and Economy (Toner & Bregha, 2009), which “adopted an interesting definition of sustainable development: ‘development which ensures that the utilisation of resources and the environment today does not damage prospects for their use by future generations’” (Tarasofsky, 2007, p. 3) – one of the first indications that a sustainable development agenda in Canada would focus on the tradeoffs between environmental degradation and the use of natural resources.

From this Task Force emerged the recommendation which created the National Roundtable on Environment and Economy, to focus on the critical public policy task of implementing sustainable development in Canada, and to deal with the interdisciplinary and trans-disciplinary challenges of sustainable development issues (Dale, Spencer, & Ling, 2006;

Toner & Bregha, 2009). The mandate to assemble leaders with diverse backgrounds (Toner & Bregha, 2009), was based on a belief that the broad membership would actually represent Canadian interests, and if consensus was reached it would “have relevance and acceptability by society in general” (Dale, Spencer, & Ling, 2006, online). Yet, the federal government announced in March 2012 through the federal budget that the work of the National Roundtable would be discontinued after this year.

The office of the Commissioner of Environment and Sustainable Development (CESD) received its mandate in 1995 from an amendment to the *Auditor General Act* (Office of the Auditor General of Canada, 2010). It was driven in large by the recognition of the “pervasive gap between rhetoric and action” in the decade following *Our Common Future* (Smallwood, 2009, p. 203). Tasked with holding the federal government accountable on issues of sustainable development, the CESD is located within the Office of the Auditor General (Smallwood, 2009). The CESD “can also receive petitions from anyone in Canada alleging breaches of environmental and monitor the responses of the relevant authorities” (Tarasofsky, 2007, p. 7). A petitions process currently underway by the researcher and a colleague will be briefly mentioned at the time of presentation.

The adoption of the *Federal Sustainable Development Act* (FSDA) in 2008 provided the legal requirement for an overarching government strategy, to be reviewed every three years (Toner & Bregha, 2009). The Federal Sustainable Development Strategy (FSDS), was first launched in fall 2010 and intends to replace the old system of individual Sustainable Development Strategies for key departments (Environment Canada, 2010), which was criticized for its “failure to establish ‘whole of government’ objectives in the sustainable development domain, a focus on procedural rather than substantive goals, a lack of measurable targets, interim

goals and schedules, and the divorce between the ‘strategies’ and the real work of the departments” (Meadowcroft & Bregha, 2009, p. 8). The general approach is vague, and often fails to acknowledge its own inherent contradictions, for example in the need to reduce greenhouse gas emissions, while supporting an increased oil and gas sector for economic reasons. The entire strategy appears to be couched in language of competitiveness and prosperity; throughout the document, mention is made of the tradeoffs required between environment and economy, echoing previous government communications. This demonstrates that the FSDS is more concerned with the impact of environmental policy on economic outcomes – and not vice versa – in its measurement of the impact and effectiveness of sustainable development policy.

Most of the commitments made by the federal government thus far have been largely process oriented – “develop a plan, bring forward a proposal” – rather than truly influencing the core work of the affected departments (Toner & Meadowcroft, 2009b). The National Roundtable researches and proposes policy, but is unable to implement it; further, it is being discontinued due to budget cuts. While the CESD cannot propose policy, it focuses on assessing the implementation of plans after the fact – only looking backwards. Though the FSDS can implement sustainable development objectives, it seems intent on maintaining the status quo and impeding real government restructuring.

The roughly 25-year history of sustainable development policy in Canada has been marked by some visionary plans with good intentions that were just never implemented well. More recently, it appears that the federal government is increasingly hostile to any sustainable development agenda. Overwhelmingly, it seems that sustainable development has never been an organizing principle in Canada because it has never been a central concern of the federal

government. The three initiatives examined in this paper are all good examples of potential “game-changing” policy players or strategies, but due to design constraints, waning interest, lack of political will, bureaucratic opposition, and poor integration and horizontal coordination, they have not effectively institutionalized sustainable development.

**Key words:** institutionalization of sustainable development; Canadian federal government; policy initiatives

## Works Cited

- Dale, A. (2009). Post-Brundtland 2007: Governance for Sustainable Development as if It Mattered. In G. Toner, & J. Meadowcroft (Eds.), *Innovation, Science, Environment Special Edition: Charting Sustainable Development in Canada, 1987-2007* (pp. 54-71). Montreal & Kingston: McGill-Queen's University Press.
- Dale, A., Spencer, C., & Ling, C. (2006). *The National Round Table on the Environment and the Economy (NRTEE): Expanded Decision-making for Sustainable Development*. Victoria, BC: Royal Roads University.
- Environment Canada. (2010). *Planning for a Sustainable Future: A Federal Sustainable Development Strategy for Canada*. Ottawa: Government of Canada.
- Meadowcroft, J., & Bregha, F. (2009). *Governance for Sustainable Development: Meeting the Challenge Ahead*. Ottawa: Policy Research Initiative.
- Meadowcroft, J., & Toner, G. (2009a). Engaging with Sustainable Development: Setting the Canadian Experience in Context. In G. Toner, & J. Meadowcroft (Eds.), *Innovation, Science, Environment Special Edition: Charting Sustainable Development in Canada, 1987-2007* (pp. 3-20). Montreal & Kingston: McGill-Queen's University Press.
- Office of the Auditor General of Canada. (2010). *Backgrounder: Commissioner of the Environment and Sustainable Development*. Retrieved December 30, 2011, from [http://www.oag-bvg.gc.ca/internet/English/cesd\\_fs\\_e\\_29451.html](http://www.oag-bvg.gc.ca/internet/English/cesd_fs_e_29451.html)
- Runnalls, D. (2009). Why Aren't We There Yet? Twenty Years of Sustainable Development: A Personal View. In G. Toner, & J. Meadowcroft (Eds.), *Innovation, Science, Environment Special Edition: Charting Sustainable Development in Canada, 1987-2007* (pp. 21-29). Montreal & Kingston: McGill-Queen's University Press.
- Smallwood, L. (2009). Advocate or Auditor? The Conflicted Role of the Commissioner of the Environment and Sustainable Development. In G. Toner, & J. Meadowcroft (Eds.), *Innovation, Science, Environment Special Edition: Charting Sustainable Development in Canada, 1987-2007* (pp. 203-229). Montreal & Kingston: McGill-Queen's University Press.
- Tarasofsky, R. (2007). Canada's Progress in Addressing the Strategic Imperatives set out in "Our Common Future": Background paper. *Proceedings of "Facing Forward looking Back: Charting Sustainable Development in Canada 1987-2007"*. Ottawa.
- Toner, G., & Bregha, F. (2009). Institutionalizing Sustainable Development: The Role of Governmental Institutions. In G. Toner, & J. Meadowcroft (Eds.), *Innovation, Science, Environment Special Edition: Charting Sustainable Development in Canada, 1987-2007* (pp. 30-53). Montreal & Kingston: McGill-Queen's University Press.



Toner, G., & Meadowcroft, J. (2009b). The Struggle of the Canadian Federal Government to Institutionalize Sustainable Development. In D. VanNijnatten, & R. Boardman (Eds.), *Canadian Environmental Policy and Politics: Prospects for Leadership and Innovation* (3rd ed., pp. 77-90). Toronto: Oxford University Press.

Wheeler, S. (2004). *Planning for Sustainability: Creating Livable, Equitable, and Ecological Communities*. London: Routledge.

# **STABILISATION OF THE SUSTAINABLE DEVELOPMENT PATH: TOWARDS A WIDER POLICY AGENDA**

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## **Stabilisation of the sustainable development path: towards a wider policy agenda**

### **Abstract**

The policy agenda for sustainable development continues to evolve in a context of technological change, globalisation, and economic restructuring. While harmony between economic and environmental objectives is a prerequisite for sustainability, there are always pressures tending to divert development away from a sustainable path.

With an increasing focus on the sustainability of economic activity, a number of now-familiar policy instruments have been deployed, including regulatory standards, economic incentive mechanisms, and informational and reputational measures. These have had some success, but they can be slow to adapt to emerging environmental issues or economic fluctuations and restructuring. Such changes can rapidly affect perceptions of short-term trade-offs, with prejudice to long-term sustainability.

A key concern therefore is to stimulate corrective mechanisms to counteract deviations from sustainability. The paper calls for a widening of the policy agenda to induce dynamic stabilisation of the development path towards a long-term sustainable trend. This broader agenda takes into account the factors that influence responses to economic and other incentives. Specific contextual issues include governance, institutional structures, resource endowments, and organisational functioning and prioritisation. Overlaid upon these are distortions due, for instance, to misperceptions, imperfect knowledge, failures of anticipation, time lags and differing concepts of rationality.

Based on analysis of the potentially destabilising effects associated with these influences, the paper seeks to develop a multifaceted framework for an extended sustainability policy agenda.

This agenda takes into account a number of elements. These include: strategic assessment of technological change; ong-term consensus building; property rights; the concept of trusteeship; refinement of economic incentives; economic and environmental dissonances; and anticipatory and precautionary approaches.

The paper goes on to consider the practical application of this framework agenda, at global, regional and local levels, with reference to economic and social structures and reconciliation of differing priorities.

## **The evolving policy agenda**

The policy agenda for sustainable development continues to evolve in a context of technological change, globalisation, and economic restructuring. While harmony between economic and environmental objectives is a prerequisite for sustainability, there are always pressures tending to divert development away from a sustainable path. To assume the continuation of present trends – business as usual – is to run the risk that development will proceed onto an unsustainable path, perhaps becoming destabilised by climate change, or conflicts over water resources, or pressures on land use.

Technological change is driven by numerous complex forces, not necessarily all of which are conducive to, or consistent with, sustainable development. Policies for sustainability are one among many influences. Their objective can be defined as guiding technological development in the direction of, at the least, weak sustainability whereby the value of the aggregate capital stock be maintained, with substitution where appropriate between natural and man-made capital (Neumayer, 1999, p.23). This means, for instance, that the use of energy from fossil fuels and nuclear power drives the economic growth that can provide resources for future generations to combat the effects of climate change and manage the legacy of nuclear wastes.

Technology is both a driver of, and also stimulated by, globalisation, a twenty first century phenomenon, defined by Martin Wolf as integration of economic activities, across borders, through markets (Wolf, 2004, p.14). The process is driven by technology, economics and politics, and it is characterised by:

- Growing integration of the international economic system.
- Increasing cross border trade, investment, capital flows.
- Consumers buying more imported goods.
- Businesses operating across national frontiers.
- Savings invested in distant lands.

Economic integration through globalisation has two major, and contrasting, effects. A lowering of barriers to trade and capital mobility facilitates the exploitation of comparative advantage, with increasing specialisation of national and regional economies. At the same time increased participation in the global economy leads to growth in inter-linkages and interdependencies between and among economic actors: enterprises, consumers, employees and governments. These interactions can also have an endogenous growth effect, offering economies of scale in the development and applications of technologies. The result is increasingly complex networks of economic activity, spanning the globe. As networks grow, the potential for change also increases. The introduction of new technologies involves discontinuities, as new products and processes follow their cycle of development. The larger the network, the more possibilities tend to exist for transmission of transformative impacts.

If economic activity is constrained to respect the limits of environmental capacity, through regulatory and/or pricing mechanisms, the interaction between these gives rise to environmental congestion. If there is little pressure on assimilative capacity the elasticity of supply of environmental capacity is high, but as pressure increases the elasticity becomes zero. Consequently additional demand can only be accommodated within an overall ceiling. This is characterised by Hirsch as "an adding up problem: what individuals want and what individually they can get, society cannot get; and society has to find some means for determining how the difference should be reconciled" (Hirsch, 1976, p.106).

The private gains from economic activity are enhanced (and the costs reduced) if the environmental impacts can be shifted elsewhere. Shifting is not necessarily an undesirable

process: it can be benign, if the polluter pays principle (in its widest sense) is properly respected. This requires the informed consent of all the parties involved, and that the costs (including environmental damage costs) are fully covered by those responsible. Such an outcome would in principle be both economically efficient and environmentally optimal; effectively, it would fulfil preconditions that are implicit in Martin Wolf's observation (quoted on p.6 below) relating to changes that make the world "unambiguously better off" (Wolf, 2004, p.191). However, if these conditions are not met the results can be economically, environmentally and socially damaging.

A further, fundamental, difficulty, which becomes apparent over time, is that a good quality environment can be counter-productive. There is liable to be a negative feedback, as the quality of life attracts further development which tends to negate the attractions. This has become known as the temporary paradise phenomenon. The expression "temporary paradise" was used in a 1974 report on the future of San Diego, which characterised the city as a "natural paradise ... beginning to suffer ... problems which undermine the very things for which people have so much affection" (Lynch and Appleyard, 1974, p.7). The problem has been well described as follows (Sudjic, 2008):

For a brief moment, they look as though they have it all: a great natural setting, cheap housing, short commutes, clean air. These are the things that allow you to live in an affordable, spacious suburban home, where you can catch a glimpse of exotic wildlife as you jump in your car for the 15-minute commute to a downtown where the streets are squeaky clean, and entirely free of crime. The trouble, of course, is that this is only a temporary paradise. As more and more people want to share it, the more that house is going to cost, the longer that commute is going to take, and the more polluted the city's air is going to become.

The process of reversion can continue further, with infrastructural inadequacies contributing to economic decline. A recent report charts a possible course, with reference to an environmentally unfriendly growth path in which transport is dominated by fossil fuel-powered cars: in this scenario "low density sprawl and fragmented suburbs are the norm. ... Detroit no longer exists, replaced by five smaller cities. There is a lot of decaying, underused car infrastructure being scavenged and repurposed" (Forum for the Future, 2010, p.27). The lesson is that globalisation is not necessarily an irreversible process inexorably extending its reach: it is crucially dependent on a mass of local and regional infrastructure that gives access to the global economy. Just as regions can build up the infrastructure to support a growing presence in the global economy, their presence can diminish with economic adversity.

The economic/environmental interface thus throws up varied challenges, in the face of which the policy agenda has to evolve. There are well-known mega-issues, such as climate change, or conflicts over water resources, or pressures on land use. Around these are economic transformations, and changes at local and regional level that influence the key phenomena relating to sustainable development.

## **Current policy instruments and their limitations**

With an increasing focus on the sustainability of economic activity, a number of now-familiar policy instruments have been deployed, including regulatory standards, economic incentive mechanisms, and informational and reputational measures. These have had some success, but they can be slow to adapt to emerging environmental issues or economic fluctuations and restructuring, which can rapidly affect perceptions of short-term trade-offs, with prejudice to long-term sustainability.

A variety of policy instruments is available to provide incentives to avoid, or reduce, damage to environment: these may be broadly categorised as:

- regulation: controls over emission sources, substances, or products, either based on what is technically feasible or geared to achievement of environmental quality standards which may be defined in terms of a single medium (for example water or air) or multiple media.
- "informational" measures: environmental impact assessment, environmental auditing, product labelling, systematic release of information.
- economic incentive mechanisms: including charges, taxes, subsidies, or liability for environmental damage

All these instruments are critically information-dependent, whether to influence behaviour, as for instance in the US EPA Toxics Release Inventory (see Hamilton, 2005), or to achieve specified policy goals with respect to emissions or environmental quality.

As environmental policies developed there was an increasing emphasis on the role of price mechanisms, as an economically efficient means of achieving environmental objectives. However these methods are not a panacea. The information available to the authorities on costs, and behavioural responses to prices, is, inevitably, incomplete, and so targeting is subject to imprecision. This has been called "the cost of making a mistake" (Ackerman, 1973, p.524).

Achievement of objectives through incentive mechanisms depends upon:

- Clarity: the linkage between the incentive and what it is designed to achieve should be evident.
- Transparency: the operation of the mechanism should be predictable.
- Understanding; the actors must be clearly aware of, and know how to respond to, the incentives that they face

The use of market mechanisms to achieve environmental objectives is thus a complex matter: it is necessary to decide on the objectives to be achieved, the nature of economic incentives, and how the system can be geared to achievement of specified targets. Performance with respect to attainment (or otherwise) also requires ex post assessment, because environmental protection and improvement is a continuing process. The targeting of carbon dioxide emissions provides a good illustration: greenhouse gases come from certain types of energy usage, but energy is not homogenous, nor are the emissions or emission sources. Consequently there are various ways in which emissions can be reduced, some of them more sustainable than others.

In some circumstances efforts to apply the polluter pays principle can be counter-productive, with respect to both economic efficiency and equity. One instance is shown in a study of the Patancheru area in Andhra Pradesh, where industrial effluent discharge caused considerable damage in the surrounding rural area. The industrial polluters paid compensation for crop damage, but this understated the true environmental damage costs (including impacts on human and animal health), particularly for the least affluent members of the community, marginal farmers without access to well irrigation. Consequently, there was no incentive to limit pollution to an economically efficient and socially acceptable level (Behera and Reddy, 2002, pp.263-65).

## **Deviations from the path of sustainable development**

The concept of a stable path of sustainable development is an attractive notion. An economic system in some way governed by automatic mechanisms, a "sustainability auto-pilot", would not need continuing policy adjustments to contend with forces that drive the system off-course, compromising its sustainability. Such a mechanism can be conceived, in principle, as the following of a "green golden rule" for sustainable optimality, incorporating resource constraints and inter-generational equity (Beltratti et al., 1995).

However, over time the parameters within the decision framework are liable to change, giving rise to possibilities of time-inconsistency. As one study put it, "unless government can make a once-and-for-all self binding commitment to a policy rule, private sector agents will expect government to "re-optimize" at later dates." The incentive to re-optimize is inherent in variation in the discount rate, such that "almost all types of declining discount rates result in time-inconsistency". Aside from this technical constraint, there are "policy inconsistencies and changes that are prompted by external shocks or political shifts." The reality is therefore that "ultimately few if any policies are optimal in an unqualified sense" (Pearce, Atkinson and Mourato, 2006, p. 190)

One example might be where a carbon tax succeeds in inducing investment in low carbon technology, and the government can then reduce the carbon tax to achieve other objectives. The consequence can either be that those subject to the tax perceive deception on the part of the authorities, or that anticipation of the relaxation of the tax prevents it from having the desired incentive effect (see Helm et al., 2004).

More generally, the values of future generations are unlikely to be the same as those prevailing today, and valuations and trade-offs may be very different. The choices that are faced in the future, and their relative attraction, are an – uncertain – function of decisions that are made in the present. In a weak sustainability scenario economic growth is supposed to provide resources for future generations to protect the quality of their environment. However, the qualitative nature of growth, and the sort of technologies that are generated, sets the context for future choices.

Matters are further complicated by the path dependency of outcomes in the midst of non-linearities. For example, the adoption of the internal combustion engine as the dominant road transport power source was complemented by the development of infrastructure: manufacturing capacity, maintenance and repair facilities and fuel supply. Road users drove petrol powered cars because other road users did so. The consequence was to preclude the widespread use of alternative power sources. The implication for sustainable development, unforeseen at the time when mechanised road transport was first introduced, turned out to be an increase in emissions of greenhouse gases.

## **Widening the policy agenda**

To induce stabilisation of the development path towards a long-term sustainable trend, the policy agenda must be widened to take into account the factors that influence responses to economic and other incentives. Specific contextual issues include governance, institutional structures, resource endowments, and organisational functioning and prioritisation. Overlaid upon these are distortions due, for instance, to misperceptions, imperfect knowledge, failures of anticipation, time lags and differing concepts of rationality.

Sustainable development, as a global challenge, calls for a co-ordinated policy response encompassing commitments across the world at all levels. However, globalisation as

presently conceived has an inherent paradox, inasmuch as international economic integration coexists with political structures at national and local levels. Defenders of globalisation argue that comparative advantage is applicable to a nation's environmental resources in the same way as to its natural resource or factor endowment. Thus, "differences in environmental standards are a natural expression of [local] autonomy. Differences in incomes, preferences and geography could quite reasonably give different localities, or countries entirely different environmental standards for local environmental spillovers. If polluting industries were then to migrate from high-standard regions or countries to low-standard regions or countries, the world would be unambiguously better off. ...The low-standard regions or countries would have more economic activity, in return for pollution to which they are, relatively speaking, indifferent." (Wolf, 2004, p.191). On the other hand it can be asked 'who is indifferent?' Evidently those who determine the environmental standards, and those who are not significantly affected by the pollution; anyone who does not come within either of these categories might take a different view.

There are indeed differences in priorities between countries, with respect, not only to local concerns, but also to those issues with relevance to global sustainable development. There are some forces that tend to promote convergence in environmental priorities and others tending towards divergence. For instance, in comparing India and the European Union (see Madhavan and Barrass, 2007), the forces for convergence include:

- India's economic development, giving rise to issues already manifested elsewhere.
- Changing economic structures - notably the influence of multinationals.
- Alignment of India's environmental standards with those of western countries following the 1984 accident at the Union Carbide plant in Bhopal.
- The growing emphasis on sustainability of development.

Meanwhile forces for divergence can be identified as:

- The increasing complexity of products and processes and their environmental impacts.
- Regional differences and disparities within the EU and India that complicate the formulation and implementation of environmental standards.
- India's increasing capacity to develop policies in accordance with its own environmental priorities.
- Growth in bilateral trade, and the development of new technologies and products.

Where activities or impacts transcend national frontiers the individual focus is obscured: the international economy and global environmental issues are usually seen in the perspective of bilateral or multilateral inter-country relations. International environmental measures are generally negotiated between countries (or, in the case of the European Union, supranational organisations): international environmental law consists of a set of treaties, and if they have a compliance procedure, it will deal only with disputes among states. The incidence of costs and benefits within countries is often ignored. The implicit assumption is that the interests of all inhabitants of each country are sufficiently homogenous to be approximated by the negotiating position of national authorities. Consequently when issues arise over who suffers from environmentally damaging impacts of economic activity, the focus has been on international equity; less attention is given to the intra-national incidence of environmental impacts. Proposals have been made for procedures that permit access to other parties, such as "NGOs, environmental associations and interest groups, enterprises and even individuals" (Rest, 2000, p.41). This might focus attention on differential incidence of economic and environmental impacts.

The increasing economic interdependence and fragmentation that characterise globalisation have their counterparts in environmental impacts, but there is often a dissonance between the two. Since integration is a dynamic process, there are time lags between economic restructuring and the environmental impacts, and between these impacts and stakeholder



responses. Furthermore economic activities are frequently distanced, spatially and temporally, from their associated environmental impacts so that there is a separation between enjoyment of benefits and the downside in the form of eventual unsustainability.

The economic and environmental impacts in this process of change have very different incidence. This is illustrated by recent experience in India. With rapid economic growth has greatly enlarged the social group identified as the "consuming class", which is estimated to have tripled in number over ten years, so that it accounted for about one fifth of the population by the end of the twentieth century. The lifestyle of this class is characterised by ownership of products such as television sets, music players, fans, watches, and refrigerators. These are the types of product that generate environmental impacts in their manufacture, use and disposal. The impacts include natural resource and energy use, as well as problems in waste management. Rapid increases in their consumption can be expected to place pressure on waste management systems. The effect is somewhat insidious, since the process operates with a time lag; today's consumption generates tomorrow's wastes. the "pockets of affluence" created by economic change contrast with the increased potential for environmental damage, in which the main victims are the less affluent who "depend directly on the environment for their basic needs" (Kandula, 2004, p.253).

Bhagwati (2004, p.141) characterises as the "real question" how to value the environment. There are legitimate reasons for variation in the trade off between different types of environmental resources and between environmental and other resources. Criticising environmental groups that seek to impose their own valuations of environmental resources, Bhagwati argues that countries have a right through their own political processes to make choices with respect to exploitation of these resources. International trade is generally defined as being between countries, but it is not obvious why the environment should be defined in this way. Indeed it is to be expected that economic globalisation would reduce the importance of national frontiers, which implies a growing alignment with environmental concerns.

Valuation of the environment is not straightforward: values are frequently inferred from observed behaviour rather than derived from market prices. Unlike market prices, the valuations are not transparently the result of trade which is mutually beneficial to the participants. Consequently they have no self evident legitimacy, and their accuracy and acceptability are open to question. If the experts who estimate the valuations are honest, their conclusions will be hedged with qualifications (for example, assumptions that changes are marginal, that consumers are well-informed, that markets are not distorted). A notable example of the use of environmental valuation techniques was the work of the Roskill Committee on the third London airport, which included estimates of monetary values for noise derived from property prices; notwithstanding its firm intellectual foundations, the committee's subsequent recommendation for the site of the new airport met with considerable opposition, and was eventually rejected by the government (this is summarised, along with other case studies, in Feldman and Milch, 1982, pp.254-57).

So the question arises: whose valuation is relevant? There is often a tension between economic activity at national or international level and environmental impacts that are manifested at a local level. Valuations attached (explicitly or implicitly) to local environmental phenomena are specific to the location involved. So problems can arise where cross border trade and investment is subject to environmental performance criteria; this is not objectionable in principle, but it begs the question of whose priorities and valuations are relevant in determining what is good - or at least acceptable - environmental performance.

Environmental valuations are frequently not explicit, and can only be inferred from actions that are taken, or measures that are advocated. Their basis is often perception, or misperception, of potential impacts and their probabilities. In the extreme, probability

estimates can be based on "knowledge" that is entirely false, such that "the voices of the wise who know that they do not know are often drowned by the ignorant who do not know that they do not know" (Kay, 2007). Probability estimates formulated in the absence of a clear understanding of causal linkages between impacts and effects do not provide a reliable basis for action: as the Pfizer judgement put it "a preventive measure cannot properly be based on a purely hypothetical approach to the risk, founded on mere conjecture which has not been scientifically verified" (CFI, 2002, para 143).

Nevertheless, there can be considerable pressures on policy-makers to take action or at least offer reassurance. In the absence of reassurance individuals may take decisions that are not necessarily well advised based what they are - rightly or wrongly - led to suspect. However, if the reassurance is not soundly-based there is a risk of damaged credibility (as shown by the UK experience in the BSE crisis, in which the authorities were perceived as reluctant to be open with the public about scientific evidence and, particularly its limitations and areas of ignorance – see EEA, 2001, p.161). If they take action, it may turn out to be wasteful, pointless or even counter-productive. If they insist on awaiting further evidence, they risk paralysis by analysis. So it is important (and admittedly very difficult) to distinguish general lessons that can be learned to aid precautionary action in the future, and avoid unhelpful invocations of the wisdom of hindsight that offer little help when a different crisis of a different sort appears on the horizon.

It is of course always possible that economic decisions are distorted by misperceptions and a lack of rationality. Lomborg (2001) hints at this in his discussion of the precautionary approach: "if we try to become more safe in some areas we spend resources that cannot be used doing good in other areas" (Lomborg, 2001, p.349). It is true that excessive effort to reduce a small risk is unjustified – but what is excessive? Is a 0.5% chance of \$1m worth of damage equivalent to a 50% chance of \$10,000 worth? Only in the special case where the decision maker is indifferent to the degree of risk. In the case of many environmental problems, the combination of irreversibility and the severity of the worst case scenario may render a degree of risk aversion understandable, and not obviously irrational.

The key problem in balancing these conflicting considerations is characterised as decision-making under uncertainty and there is extensive literature on optimisation in the face of uncertain outcomes (see for instance McKenna, 1986). Models of decision-making in these circumstances assume given, known and consistent, preference patterns. However preferences may not necessarily be rational in the sense of global consistency. It is possible that individuals can form instantaneous first order preferences that may dominate their "true" longer-term second order preferences, thereby distorting the time-dimensions in decision-making. An immediate first order preference for junk food as a relatively low cost means of alleviating one's hunger may co-exist with a second order preference for organic food as a key to longer-term health benefits (see George, 2001, p.25). The implication is that first order preferences would discount the future at a higher rate.

Societal preferences can also manifest this dichotomy. For instance, an EEA report on the precautionary principle concluded that "the absence of political will to take action to reduce hazards, in the face of conflicting costs and benefits, seems to be an even more important factor ... than is the availability of trusted information" (EEA, 2001, p. 4). The problem is that the political will is not necessarily homogenous: so, for instance, politicians who proclaim their commitment to combat climate change, reflecting voters second order preferences, also fight shy of measures such as restriction of low cost air travel that would run counter to the voters' first order preferences.

## **A conceptual framework for an extended sustainability policy agenda**

From the analysis presented above there emerges a multifaceted framework for an extended sustainability policy agenda. Specific elements of this agenda include:

- Strategic assessment of technological change.
- Long-term consensus building.
- Property rights.
- The concept of trusteeship.
- Refinement of economic incentives.
- Economic and environmental dissonances.
- Anticipatory and precautionary approaches.

### *Strategic assessment of technological change*

The course of technological change is notoriously difficult to predict. Strategies for sustainability must have regard to technological development, and – even if only implicitly – incorporate perspectives on its future course, and the environmental implications. In developing responses to long term environmental pressures, notably climate change, we can be sure that economic structures and technologies in the future will be very different from those at present; but it is a highly speculative matter to predict how they will change. Past experience shows the importance of unanticipated discontinuities. In 1880 New York had a population of 1.8 million, and 150,000 horses that generated 1596 tons of manure every day; this generated a massive pollution problem (Tarr, 1971). If the horse population increased pro rata with the human population we could now expect to find a huge labour force engaged in clearing horse manure to prevent the streets becoming impassable and unhealthy. This did not happen, due to a technological discontinuity in the form of the internal combustion engine. It is not clear, even in the historical perspective of over a century, whether the course of technological change in this instance constituted a move towards or away from sustainable development; much depends on counter-factual assumptions as to how development might have proceeded otherwise.

### *Long-term consensus building*

The evidence of biology might suggest that nature favours short time horizons: thus "evolution's favoring of organisms that respond to local or near-term events results in a steep ... discount rate for distant ... events (Paulos, 1996, p.96). On the other hand sustainability implies an ethical position such as the Rawlsian just saving principle, whereby each generation altruistically cares for its successor, such that a generation's well-being "depends not only on its own consumption level, but also on its descendents' consumption levels" (Dasgupta, 2005, p.9).

The inter-generational impacts of a development path only become apparent beyond any decision-making time horizon defined with reference to conventional economic criteria. In economic analysis the time horizon is conceived in two ways. For practical purposes it is implicit in the use of a discount rate that defines relative valuations of distant and near events; if a cost or benefit is sufficiently far into the future, discounting will render its present value negligible. The horizon can also be set with reference to the short run, in which there is only limited scope for adjustment; this is distinguished from the long run, in which all factors are variable, and in which, as J M Keynes memorably remarked, "we are all dead".

Nevertheless, a concern for long-term sustainability implies thinking beyond the time horizon. In which case it is necessary to consider the basis for discounting future costs and benefits in the very long term: and unfortunately "the biggest uncertainty of all ... is the uncertainty about

which interest rate to use for discounting" (Weitzman, 2007, p.705). Positive discount rates are normally justified on the basis of future economic growth (so that the marginal utility of future consumption is less than that of present consumption) and a pure time preference for enjoyment earlier rather than later. The latter implies a question: whose preferences? It makes sense for an individual (or group of individuals) making judgements about the timing of their own consumption now and in the future, but its ethical basis is dubious in inter-generational welfare comparisons. This issue is faced in the Stern Report to the UK government on climate change, which states that "a future generation ... has the same claim on our ethical attention as the current one" (Stern, 2006, p.31). In other words there must be inter-generational equity.

#### *Property rights.*

A bargaining process can protect the environment if the persons affected enjoy property rights over the environment, and if they are in a position to defend their rights (see Coase, 1960); this requires informed consent among the parties, and that the outcome is, at least potentially, mutually beneficial. However, in practice these pre-conditions often do not hold: for instance financial compensation will have little meaning for communities who have very little participation in the market economy (see for example CSE, 2008, for an account of this issue in the case of mining developments in tribal regions of India). So a strengthening of property rights may contribute to sustainable development, but it cannot have the status of a panacea.

#### *The concept of trusteeship.*

Another step is to make more explicit the nature of trusteeship, and the responsibility for safeguarding the interests of potential victims. Economic incentives should be consistent with sustainability: so it is necessary to reconcile a natural tendency of organisations and individuals, to focus on narrowly defined and short-term advantage with society's wider and long-term interests. Above all it is vital to guard against complacency: to be prepared for the unexpected, and to attempt to come closer to imagining the unimaginable.

#### *Refinement of economic incentives.*

The key question remains one of institutional capacity to determine the course of development, and to ensure its sustainability. Paulos (1996, p.96) recommends "a Global Reserve Board to help decide on more rational discount rates"; but is not clear how this could work within a market economy. Clearly, the incentives facing individuals and organisations should favour actions consistent with sustainable development, and specifically investment that makes adequate substitution for the natural capital stock. The debate on climate change measures has highlighted the issues surrounding the discount rate for ultra long-term impacts. In the short-term, behaviour typically implies a massive discount on any impacts beyond the fairly immediate future. The investment decisions of enterprises are to a great extent driven by the terms on which finance can be raised; and the monetary authorities use short term interest rates as the instrument of monetary policy. If financing becomes more expensive, businesses discount the future more heavily, seeking higher returns on marginal investment. In contrast, a sustainable development strategy calls for low discount rates for inter-generational effects, and for investment and technological change that specifically meet the requirements of (at least weak) sustainability. To ensure that market behaviour conforms to this strategy would seem to require a conscious reorientation of incentives. This would imply that the authorities should make investment financing and fiscal measures subject to tests of consistency with the strategy.

### *Anticipatory and precautionary approaches.*

Uncertainty is an inherent feature of many environmental issues; indeed the prominence of some issues on the policy agenda is due (at least in part) to this uncertainty and to the severe implications of the worst-case scenario. One possible response is to be in denial: to have a bias (even if unconsciously) towards the knowable and the known, and to the familiar - in other words to focus attention on problems that are well defined, and amenable to assessment and remedial measures with reference to a particular analytical perspective. The precautionary principle tends to counter this bias, if applied in a way that adapts established perspectives to dealing with possibly unfamiliar phenomena that are subject to uncertainties.

An early statement of the precautionary principle, which is the basis for most subsequent formulations, is found in Principle 15 of the 1992 Declaration of the UN Conference on Environment and Development (UNCED) in Rio de Janeiro. "In order to protect the environment, the precautionary approach shall be widely applied by States according to their capabilities. Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation."

Consequently following the precautionary approach means higher costs, lower output and hence lower profits. Is this sacrifice worthwhile? The additional costs can be regarded as an insurance premium. There is a recurrent cost of being precautionary, but it could be judged worthwhile, with hindsight, if it were at some point to avert (or at least mitigate) a major crisis. The implicit assumption is of course that the crisis comes from a quarter that is anticipated by the precautionary measures. There is a danger of a Maginot line mentality, a prime example of a precautionary measure that proved ineffective due to a failure of lateral thinking.

The conceptual framework for a wider policy agenda includes elements of the existing agenda in some measure. What has been argued here is that this framework needs to be explicitly recognised and developed and must inform practical policy making aimed at achieving a stable path for sustainable development.

### **Practical application of the framework agenda**

Sustainable development is an extremely complex and many-faceted issue. It cannot be encapsulated in a straightforward set of rules or criteria. As one economic commentator observed "questions like 'How will economic and political systems deal with climate change?' are fundamentally and irretrievably open-ended. We cannot describe the range of outcomes in probabilistic terms, and decades from now there will still be disagreement over what the outcomes proved to be" (Kay 2010, p.103).

In the face of these complexities, the policy agenda must evolve, and be applied, pragmatically. At the outset it is necessary not only to be concerned over the long-term course of development, but also to recognise the difficulties in securing general acknowledgement of the causes for concern and the consequent need for action. As Ariely (2011, p.251) put it, global warming is a good example of a problem liable to inspire general indifference, because:

- it is an immediate issue mainly for poorer countries,
- it is not immediately observable,
- it involves largely imperceptible changes,
- its greatest and most evident impacts will only be manifested in the distant future.

It is furthermore a notable instance of "the drop in the bucket effect", inasmuch as "any action taken by any one of us is far too small to have a meaningful influence on the problem" (Ariely, 2011, p.252).

The challenge then is to generate an adaptation in perspectives, an instance of what Kay characterises as "obliquity", "recasting problems to achieve our objectives more effectively than we had conceived" (Kay 2010, p.78).

One way forward is to induce more widespread ownership of sustainability concerns, with corresponding commitments to action. This is to counter the causes of indifference mentioned above, the propensity to delay taking action while recognising in the abstract that there may be problem. In psychological terms "the best course might be to give people an opportunity to commit up front to their preferred course of action ... we have problems with self-control related to immediate and delayed gratification ... but each of the problems we face has potential self-control mechanisms" Ariely 2009, p.117).

A further facet of this approach is to exploit the so-called "endowment effect". Put simply, this states that the value that people place upon their possessions often exceeds the price at which they would be prepared to buy them (if they did not already own them) (see Kahneman, 2011, p.295). Associated with this effect is the phenomenon of loss aversion, whereby an actual loss appears more significant than a foregone gain of the same amount (Kahneman, 2011, p.308). The key to these concepts is a reference point for valuation, determined by the perception of utility derived from ownership. If sustainable development is conceived as an entitlement, a property right, there could be more awareness of its value, and a lesser tolerance of behaviour that compromises sustainability.

Pursuit of policy objectives through indirect influence on preferences and behaviour has been characterised as "libertarian paternalism", which recognises that "humans ... need help to make good decisions, and there are informed and unintrusive ways to provide that help" (Kahneman, 2011, pp.414-15). This approach was deployed to combat climate change in the US EPA programmes to promote energy efficiency. These programmes helped companies to reduce their expenditures on energy, and their success could be seen as a refutation of the standard economic theory that "in a market economy firms should not need the government's help to cut their own costs". The reality is somewhat more complex: firms are always incentivised to reduce costs, but pursuit of cost cutting avenues is a matter of prioritisation, and it can be that energy cost savings are "small relative to the bottom line" (Thaler and Sunstein, 2009, p.209).

A key element of the implementation strategy is therefore a widespread change in perceptions and presumptions. This is linked to a precautionary approach that influences preferences and priorities, which depends in large measure upon public trust. A further facet of this approach is flexibility, and adaptability to changing circumstances in the face of inevitable uncertainties.

A continuing commitment to the sustainability agenda can be secured only if its influence permeates the primary institutions of society, which define identity and the rules governing social interaction. Thus "if environmentalism is to effect lasting change in international society, we should expect it to leave traces at the level of primary institutions ... The creation of international environmental regimes and organizations ... should not be mistaken for the greening of international society as such" (Falkner, 2012, p.509).

Even with a greening of society there would not be uniformity. Differences in perspectives and priorities within and between societies are inevitable, legitimate and not necessarily undesirable. It is nevertheless important that at international level trade-offs in economic and

environmental policies should be explicit, having regard both to mutual interests in the functioning of the global economic systems and to differences in interests and priorities.

Typically strategies for implementation of the precautionary principle are geared to rational scenarios in which impacts and their causation are known, or will become known with further research. A good example is found in guidelines developed by the Precautionary Principle Project, a joint initiative of conservation bodies (PPP, 2005). The principle is to be implemented by:

- monitoring of impacts of management or decisions based on agreed indicators;
- promoting research, to reduce key uncertainties;
- ensuring periodic evaluation of the outcomes of implementation, drawing of lessons and
- review and adjustment, as necessary, of the measures or decisions adopted;
- establishing an efficient and effective compliance system.

These are sound strategies for a rational and objective decision-making process. However they do not cater for situations in which perceptions and preferences are not necessarily well informed or consistent.

A further requirement is clarity with respect to the extent and meaning of "knowledge". This goes beyond the admission of ignorance and uncertainty, essential though this is; it calls for a very high degree of humility and open mindedness. Such a state of mind can be difficult to maintain, particularly where there is a long-standing commitment to a certain set of perspectives. There also needs to be a recognition of biases in the relative importance ascribed to, and the interpretation of, information, and hence in setting priorities for action. These can be influenced by the differing analytical perspectives of professionals in ways that are often subtle and difficult to perceive. The can for instance be biases:

- from a biological perspective towards phenomena that are better understood;
- from an economic perspective towards impacts that are subject to market valuation and affect economic indicators.
- from a legal perspective towards measures dealing with behaviour and its effects that can be clearly defined and where the responsibility of the parties involved can be determined.

Most importantly, those who (albeit unconsciously) assume a continuation of the status quo are not best equipped to anticipate crises arising from unexpected quarters. Herein lies the fundamental difficulty. Wide ranging consultation exercises will generate large amounts of information and views on future developments. Much of this will be, for various reasons, unhelpful; some will provide valuable insights to inform precautionary action. A real decision-making process, which does not have the aid of hindsight, can have difficulty in distinguishing between the former and the latter.

## References

Ackerman SR (1973) Effluent Charges: A Critique *Canadian Journal of Economics* VI (4) 512-28.

Ariely D (2009) *Predictably Irrational* Harper Collins.

Ariely D (2011) *The Upside of Irrationality* Harper Collins.

Ayres R U, Bergh J C J M van den and Gowdy J M (1998) Viewpoint: Weak Versus Strong Sustainability [www.tinbergen.nl/discussionpapers/98103.pdf](http://www.tinbergen.nl/discussionpapers/98103.pdf).

Beltratti A, Chichilnisky G and Heal G (1995) Sustainable Growth and the Green Golden Rule, in Goldin I and Winters LA *The Economics of Sustainable Development* Cambridge University Press.

Behera B and Reddy V R (2002) Environment and Accountability: Impact of Industrial Pollution on Rural Communities *Economic and Political Weekly* 257-65.

CFI (2002) Judgment of the Court of First Instance, Case T-13/99, Pfizer v Council of the European Union.

CSE (2008) *Rich Lands Poor People: is 'Sustainable' Mining Possible?* Centre for Science and Environment, New Delhi.

Coase R (1960) The Problem of Social Cost *Journal of Law and Economics* 3 (1), 1-44.

Dasgupta P (2005) Three Conceptions of Intergenerational Justice, in H. Lillehammer and D.H. Mellor eds. *Ramsey's Legacy* Clarendon Press Oxford.

EEA (2001) *Late lessons from early warnings: the precautionary principle 1896–2000* European Environment Agency Environmental issue report No 22, Office for Official Publications of the European Communities, Luxembourg.

Falkner R (2012) Global environmentalism and the greening of international society *International Affairs* 88(3) 503-22.

Feldman EJ and Milch J (1982) *Technocracy versus Democracy: the Comparative Politics of International Airports* Auburn House, Boston, Mass.

George D (2001) *Preference Pollution: How Markets Create the Desires We Dislike* University of Michigan Press, Ann Arbor.

Hamilton J (2005) *Regulation through Revelation: the Origin, Politics and Impacts of the Toxics Release Inventory Program* Cambridge University Press.

Helm D, Hepburn C and Mash R (2004) Time-Inconsistent Environmental Policy and Optimal Delegation, Oxford University Department of Economics Discussion Paper 175.

Hirsch F (1976) *Social Limits to Growth* Routledge and Kegan Paul.

Kahneman D (2011) *Thinking, fast and slow* Allen Lane.

Kandula K (2004) Population, Consumption and Environment, in Chhokar KB, Pandya M and Raghunathan M eds *Understanding Environment* Sage Publications.

Kay J (2007) Energy wisdom is knowing that you do not know *FinancialTimes* May 29, p.15.

Kay J (2010) *Obliquity: Why Our Goals Are Best Achieved Indirectly* Profile Books, London.

Lomborg B (2001) *The Skeptical Environmentalist: Measuring the Real State of the World* Cambridge University Press.

Madhavan S and Barrass R (2007) Globalisation and the Environmental Priorities of the European Union and India, in Batavia B and Nandakumar P (eds.) *Globalization: Capital Flows, Competition, and Regulation* APF Press.



- McKenna C J (1986) *The Economics of Uncertainty* Wheatsheaf, Brighton.
- Miller RW (2010) *Globalizing Justice: The Ethics of Poverty and Power* Oxford University Press.
- Neumayer E (1999) *Weak versus Strong sustainability: exploring the limits of two opposing paradigms* Edward Elgar.
- Page EA and Proops J (2003) *Environmental Thought* Edward Elgar.
- Paulos J A (1996) *A Mathematician Reads The Newspaper* Penguin.
- Pearce DW, Atkinson G and Mourato S (2006) *Cost-benefit analysis and the environment: recent developments* OECD, Paris.
- PPP (2005) *Guidelines For Applying The Precautionary Principle To Biodiversity Conservation And Natural Resource Management* The Precautionary Principle Project – a joint initiative of Fauna & Flora International, IUCN-The World Conservation Union, ResourceAfrica and TRAFFIC.
- Rest A (2000) The Role of an International Court for the Environment, Working Paper for the Conference "Giornata Ambiente 2000", Rome, 10th November 2000.
- Stern N (2006) *Review on the economics of climate change* Cambridge University Press.
- Sudjic D (2008) Keeping cities alive *The Age* May 13.
- Taleb NN (2004) *Fooled by Randomness: the Hidden Role of Chance in Life and in the Markets* 2nd. Ed. Texere, New York.
- Tarr J A (1971) Urban pollution-many long years ago *American Heritage Magazine* October 1971.
- Thaler RH and Sunstein CR (2009) *Nudge: Improving decisions about health, wealth and happiness* Penguin Books.
- Weitzman M L (2007) A Review of the Stern Review *Journal of Economic Literature* Vol. XLV pp. 703–724.
- Wolf M (2004) *Why Globalization Works* Yale University Press.

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## The social construction of sustainability in EU fisheries policy

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Track 1C

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## **Abstract**

Ecological, economic and social sustainability is prioritized in the proposal for a reformed European Union Common Fisheries Policy (CFP). At the same time it is acknowledged that there is a lack of knowledge about the meaning of different aspects of sustainability in practice. Addressing this, this article adopts a social constructivist approach to the meaning of sustainability. We assume that, since the meaning of sustainability is not posited in policy itself, it is a quality that emerges as policy is articulated and implemented in social interaction between different fisheries stakeholders. Sustainability must therefore be understood as a process. To illustrate how sustainability is socially constructed we analyze two Swedish seminars where fisheries stakeholders discuss two central principles in the proposal for a reformed CFP: a ban on the over-board discarding of fish with no commercial value, and the regulatory management mechanism of Individual Transferrable Quotas (ITQ). The analysis shows how all species of fish that are caught first become defined as a specific kind of resource and then framed as a moral issue. Once morally charged and made into an urgent societal issue, the resource including formerly non-commercial species is subjected to valorization through economic modeling. It is concluded that, as a result, all aspects of sustainability in fisheries become reliant upon the creation of new markets.

Keywords: sustainability, small-scale coastal fisheries, CFP, markets, discarding ban, ITQ

## **Introduction**

The EU Common Fisheries Policy (CFP) is generally acknowledged to be a massive environmental, economic and social failure. Fisheries management policy in the EU is embedded in several layers of complex institutional regulation and the current situation is described in policy documents in terms of overfishing, fleet overcapacity, heavy subsidies,

low economic resilience and decline in the volume of fish caught. In fisheries discourse and media coverage professional fishermen often get the blame for resource depletion and wasteful practices – and hereby also for the failure that the CFP is represented as. In the proposal for a new and reformed CFP, these problems are addressed through a focus on economic, environmental and social aspects of a sustainable development of fisheries (EC, 2011). Two cornerstones in developing sustainability in this regard are a ban on discards and fisheries management by the introduction of Individual Transferrable Quotas (ITQ).

The over-board discard of unwanted by-catches means that species of fish with no identified or negative commercial value are thrown back into the water. The rationale behind the practice of discarding – and thereby killing – fish is economic, since fishermen is fishing on fixed quotas and therefore want to avoid filling these quotas with fish that has no commercial value when it is landed. In November 2011 The Royal Swedish Academy of Agriculture and Forestry (RSAAF) hosted a seminar on a proposed ban on discards of by-catches. The rationale behind the proposed ban is to get a better estimate of the status of marine ecosystems since all catches are supposed to be landed. Consequently, a realized ban demands a commercial function for all the species of fish that are landed. The European Commissioner for Maritime Affairs and Fisheries opened the seminar by addressing the collective of European professional fishermen. The Commissioner acknowledged that “discarding is the brainchild of EU policy” and that “the policy makers are the drivers of discarding”. She officially lifted the blame from fishermen but at the same time reinforced a notion of otherness by stating that (emphasis in original) “*they* [fishermen] are in a box of *our* construction”.

To break up this box, alternative resource management approaches with improved dialogue between stakeholders are proposed as a critical issue in the reformed CFP. Improved dialogue is particularly crucial in order to gain legitimacy for possible areas of contestation in the

proposal for a new policy. However, in contrast to this ambition the RSAAF seminar was designed according to a hierarchical logic reflecting the top-down structure of the present and failed CFP. The speaker list was as follows: the EU Commissioner, the Swedish Minister of Agriculture, the Norwegian Minister of Fisheries and Coastal Affairs, the Danish Minister of Food, Agriculture and Fisheries, a panel discussion with these speakers (after which they left the seminar), the vice chairman for the Baltic Sea Regional Advisory Council (representing fishermen and other practitioners), the chairman of the North Sea Regional Advisory Council, a representative of the Norwegian coastal guard, two professional fishermen (each given the least time of all speakers), a well-known Swedish chef, and a panel discussion among invited politicians from most of the parties in the parliament plus the chef. In institutional terms this list can be read as supra-national legislation [translated into] national context [commented upon by] regional advisory councils [jumping to policing of legislation through] enforcement mechanisms [aimed at] fishermen [for the benefit of] consumers and finally [expressed as] ideological consensus. This consensus was reached top-down rather than bottom-up.

In a similar manner, in January 2012, the Scanian County Administrative Board (SCAB), the governmental body responsible for the regional implementation of EU and national policy, hosted a seminar on the proposal to structure a reformed CFP around ITQ and their application to small-scale coastal fisheries. ITQ assigns a fixed quota to individual fishing vessels, and these quotas can then be sold to other vessels under certain conditions and restrictions on national or regional markets. The point of ITQ is to downsize fleets through market mechanisms and to create economic viability among the remaining fisheries at the level of individual firms. At this seminar, representatives from SCAB itself, local coastal municipalities, the Department of Agriculture, The Swedish Agency for Marine and Water Management and a University economics department were among the invited speakers. The academic representative was invited to explain the ITQ system and the economic modeling

behind it. It was made explicit that no professional fishermen were included since they were supposed to be motivated by monetary interests that would purportedly not be constructive in policy discussions. ITQ, in combination with a ban on over-board discards, is in EU policy assumed to result in better fisheries economies and give a scientifically based estimate of the status of fish populations since all catches is supposed to be landed.

However, reading the proposal for a revised CFP a “*lack of focus* in the objectives on environmental, economic and social sustainability” is identified as a primary problem (EC, 2011a, p. 1), at the same time as the overall goal is explicitly expressed as to reach environmental sustainability (p. 2). What this shows is that even if there are difficulties in assigning meaning to the three aspects of sustainability, there are specific ways of defining problems and solutions which none the less fix the nature of this meaning. This is problematic because the economic modeling that is used to establish solutions to the problems – in particular the concept of ITQ – relies on the reduction of social complexity (Fleetwood, 2007; cf. Alexander, 2005). This reduction is assumed to facilitate both the goal of environmental sustainability by letting market mechanisms force a balance between resource status and supply, and social sustainability by ensuring monetary input to coastal communities. Both human/environment interaction and social cohesion is thus assumed to follow from the reduction of the complexities of social reality. This means that a conflict between different rationales is embedded in the proposal for a reformed CFP. Addressing this, the article investigates the relation between different aspects of sustainability by demonstrating the social construction of this concept in EU fisheries policy. We do this by using the RSAAF and SCAB seminars in an analysis of how fish and fisheries practices are talked about, valued and fixed in relation to each other. This allows us to show how the meaning of different aspects of sustainability are articulated and legitimized in emerging policy.

## Study design and methods

The study uses two seminars on European, national and regional fisheries policy. The first was hosted by RSAAF on November 23, 2011. The seminar was video recorded by RSAAF and the video was subsequently made accessible at [www.ksla.se](http://www.ksla.se). This allowed us to make a detailed verbatim investigation of policy discourse as it emerged at the seminar.

The second seminar was hosted by SCAB on January 27, 2012. A number of stakeholders with policy-making mandates were invited to speak. Professional fishermen were explicitly not invited to the seminar, although one fisherman participated in another function. This seminar was documented by taking notes and in some cases taking verbatim quotes. The SCAB chairman subsequently summarized the seminar in text and distributed this to the participants. We have used this summary as a way to secure our understanding of the seminar discussions.

We use a social constructionist approach to analyze this material. Social constructivism is an epistemological approach that stresses how meaning is created in social interaction (Potter, 1997:98): “The world is not ready categorized by God or nature in ways that we are all forced to accept. It is constituted in one way or another as people talk it, write it and argue it.” The premise for acknowledging this approach is that language is socially constructed. Our understanding and ways of knowing the world therefore becomes socially constructed as well (Wenneberg, 2001:12).

This epistemological approach facilitates an analysis of how different stakeholders talk about and understand fish and fisheries practices, and how different values are articulated in relation to each other. Social constructivism is a critical perspective. We use it here to investigate two complex situations where certain rationales and possible outcomes are given precedence over alternative ones. In this way, the analysis is one way to deconstruct a process with characteristics that are otherwise easily taken as given or determined. Towards this end, the

analysis first focuses on the rhetorical use of the term ‘resource’ and how different stakeholders frame fish as a resource. It is then demonstrated how the resource is constructed in a way that makes it possible to subject it to economic valorizations.

The two seminars in the analysis have no direct causal connection since they were organized independently of each other. They are topically and geographically connected through the policy governance structure that posits that The Swedish Agency for Marine and Water Management together with the Department of Agriculture articulates national fisheries policy in relation to EU policy, which is then operationalized by regional County Administrative Boards. This connection makes it possible to perform a multi-sited analysis of two central and co-constitutive principles in the reformed CFP.

### **The sustainability of small-scale coastal fisheries**

Small-scale coastal fisheries are interesting for a number of reasons related to sustainability.

They have a relatively low degree of environmental impact due to low fuel consumption and the use of passive and selective catch methods and gear. For the purpose of this study, the primary relevance of small-scale coastal fisheries is that they link directly to coastal communities, many of which have experienced sharp economic and social decline as a result of the failure of supra-national fisheries policy. The different aspects of sustainability mobilized in the proposal for a reformed fisheries policy – environmental, economic and social – are intimately associated with each other in a practical, everyday manner in such communities (Höjrup, 2011). Consequently, as the crisis of fisheries management is addressed at the level of policy making, this localized aspect of small-scale coastal fisheries is represented as an important value in the reformation of the CFP (EC, undated).

However, in congruence with the identified lack of meaning given to the three aspects of sustainability, little is said about the practical meaning of the social value of a new CFP. In an



impact assessment study accompanying the proposal for a reformed CFP (EC, 2011b, p. 27) social sustainability means “To increase the quality of employment [and] to give alternative development options to coastal communities”. The expression suggests a solution to a problem – lack of employment and of alternative opportunities for professional fishermen in small-scale fisheries. In a sense, non-defined meaning is indirectly fixed. As a result EU policy becomes performative. Meaning emerges as policy is talked about and implemented rather than being defined a priori. The meaning of central concepts emerges in practice. In ontological terms, this corresponds to a transition from what Czarniawska (1993, p. 8) call *ostensive* to *performative* definitions:

Ostensive definitions assume that social processes are basically identical with physical objects, that they have a limited number of determined properties which can be discovered and described ‘from outside’, and then demonstrated to an audience /.../ Performative definitions, on the other hand, are /.../ always created ‘on the inside’, by people using the language.

An ostensive policy would decide the meaning of sustainability as a given property of the policy itself, while a performative policy orders social life as the policy is articulated and applied. What consequences does a performative policy have for the intended goals of that policy? This is no trivial question. Implementing a policy for sustainable development with a lack of focus on the meaning of the central components of sustainability can result in a situation where the most easily defined or measured aspect gains precedence (Alexander, 2005; Fourcade, 2011; Kuttner, 1999). When it comes to the different aspects of sustainability, the economic dimension is often prioritized due to the measurability of parameters used to define this dimension (cf. McClanahan, Castilla, White & Defeo, 2009; Missimer, Robèrt, Broman & Sverdrup, 2010). The communication from the EC illustrates this. Reading the Commission’s communication on the proposal for a new CFP as a narrative,

the three aspects of sustainability is first tied together in an attractive package (EC, 2011c, p. 2):

The CFP has enormous potential to deliver the building blocks for sustainable fisheries that respect the ecosystem as well as providing high-quality, healthy fish products for European citizens, thriving coastal communities, profitable industries producing and processing fish, and attractive and safer jobs.

This argument for a reformed CFP is then built up as an interaction between economic and ecological aspects of sustainability. It is stated that “Sustainability is at the heart of the proposed reform”. Sustainability, in turn, is expressed as being dependent upon management, but not the management of the resource itself but of the regulatory structure of fisheries. Here, sustainable fishing “would free the catching sector from depending on public support” (p. 2), while “A strong /.../ industry operating under market conditions would play [an] active role in managing stocks” (p. 2-3). Environmental status is posited as resulting from economic restructuring towards a deregulation of fisheries economies. This economic restructuring is modeled according to neoclassical economic thinking where a market for ITQ is assumed to result in an ideal balance between resource status and supply. It is an example of the ‘embeddedness of economics in economies’ (Callon, 1998), where economic models deliberately made free from social complexity are used to shape social life (Fleetwood, 2007; Siler, 2007) by ‘defining the situations it describes’ (Graeber, 2001, p. 7).

But how is this policy articulated? How is EU policy performative in the sense that constructs and orders social life? We will illustrate this in an analysis of how a problem with discarded fish is made into a moral problem, how a failed fisheries policy is made into a problem of wasted food, how wasted food becomes valuable on new markets, and how an economic

model relying on the absence of social complexity frame and legitimize policy through the creation of new markets.

### **The social construction of sustainability**

The construction of a social, economic or moral problem is most effective and persuasive when it in some way denies ‘the complexity of the real world’ (Loseke, 2003, p. 93). In view of this, how did the stakeholders at the seminars choose to express their understanding of the problems associated with discards and ITQ in relation to small-scale coastal fisheries? How did they demonstrate the issues at stake and how were these issues constructed as urgent?

### **Problem construction: the moral framing of fish as food**

At the RSAAF seminar on the proposed ban on discards, one crucial aspect for policy makers was to first engage the public in the articulation of a problematic issue of a specific social character, and then showing that the problem was possible to solve. To demonstrate the possibility for change is rhetorically important: the road ahead is already imagined, now it is only a matter of realizing policy. Policy solves problems but also creates new ones, and this was addressed implicitly as well as explicitly in the different speeches, but the general priority was to define the problem and represent it as critical and solvable. The Norwegian minister expressed the problem by a focus on the social function of fishing (emphasis added): “Fish is *food* and we cannot accept that it is thrown away. Sustainable management is the fundament of Norwegian fisheries”. Although not a member state, Norway has had a ban on over-board discarding for 25 years, and because of this the Norwegian experience was represented as important to share. The Norwegian minister chose to talk about fish as food. By framing the problem in this particular way, a moral approach became possible by the qualification that it is not acceptable to throw away food. This was not the only possible outcome. An alternative order of justification (Boltanski & Thévenot, 1999) – another way of claiming priority –

would for example be to focus on the moral wrongfulness of killing animals. This would have given the discourse a different direction.

The Commissioner elaborated on the subject:

In the North Sea 500 000 to 900 000 tons are thrown away each year, and this represents food for between 200 000 and 400 000 people. To throw this food away is morally wrong, and especially dire in the middle of a serious economic crisis.

The premises of this statement were complex. It did not a priori grade the wrongfulness of discarding practices. The fish that up to now has been discarded has not fulfilled any function on a commercial market. Therefore, to throw this fish overboard followed a clear logic since it has had made no economic sense to land it. The way to change this logic in policy was to propose a ban on discards at the same time as it was stated that from now on, all fish will be given a commercial function (EC, 2011d). In other words, the seminar included the discursive construction of markets that previously did not exist. The emerging markets would encompass all species of fish, and all fish would be given a price on these markets.

But the Commissioner's statement said more than this. There was also a grading in the morality of throwing food overboard. Under the conditions of a serious economic crisis, the moral implications were especially dire. The moral framing of the problem was nuanced by the expression "especially dire". Hereby, the moral dilemma became relational. The grading was made operational by relating the problem to a more overarching problem, in this case a serious economic crisis. The construction of the moral grading followed a logic where the problem was framed by a 'because', prioritizing economic growth over other possible orders of justification. This allowed the moral dimension to remain intact within a kind of meta-construction. According to this model it would still be morally wrong to throw away food if

we lived under conditions of abundance. But *in relation* to a serious economic crisis the moral problem was significantly enhanced.

When a problem is constructed as a moral one in terms of right and wrong, that is, when language becomes morally charged, it is made urgent. At the seminar, the problem was constructed in a way as to make both the participants and the wider public acknowledge the problem and furthermore to agree that the present situation was immoral. The Commissioner's statement was rhetorically effective since it aligned itself with underlying moral values such as 'you should not throw away your food'. It corresponded to common cultural understandings of what is considered right and wrong, for example not to waste food because this reproduces global social injustice or that the climate change effects of food production make throwing away food morally reprehensible.

### **From food to a limited resource**

Generally, the articulation of narratives of social problems from assumptions of common sense makes them powerful in the ordering of social life (Loseke, 2003, p. 93):

/.../ these stories are public because successful stories can become a part of the popular wisdom – what 'we all know' about the world [for example that people starve and that the climate is changing]. As such, successful social problems formula stories can become a resource used by audience members to evaluate the believability and importance of other claims about social problems.

The seminar statements stressed that fish is food. Hereby, the problem of inefficient fisheries policy was framed and made urgent through a moral upgrading enabled by prioritizing economic growth. Talking of fish as food, and furthermore including fish that formerly was not acknowledged as food, served a purpose: to make it possible to develop the argument by introducing the concept of fish as 'resource' – a food resource. By the discursive construction

of a new market, so far untapped parts of marine ecosystems became a resource by the mobilization of a moral upgrading. This translation allowed for a problematization where notions of a market and market compliance were given precedence in the continued argumentation. The Swedish minister established that: “Neither fishermen nor consumers accept that enormous amounts of fish are thrown away. It is such a huge waste of a food resource”.

In this statement fish was represented as a food resource that due to market arguments must not be wasted. Waste connotes a negative value. However, this negative value was not in itself a simple fact but a valuation that relied upon the assumption of fish as a resource.

As food, fish was now reframed in two ways. First, it had been assigned a central place in a repertoire of common sense valuations morally expressed in the context of everyday household economy. Secondly, from having been a resource in abstract terms of economics and marine biology, fish was established as part of a vital food chain, a food resource among other important food resources. It was made into a concrete subject in a context that the public could relate to and whose meaning it was possible to judge. Fish was ‘socialized’; it had become the “resource used by audience members to evaluate the believability and importance of other claims about social problems” (Loseke, 2003, p. 93). The rhetorical importance of talking about fish as a resource was that it could be positioned relationally to other resources. The rhetorical maneuver opened the possibility to reflect over – and thereby argue – whether fish is a food resource that should be prioritized.

Implicitly, the public could now relate the importance of this resource to other resources and make moral judgments to support or challenge the emerging discourse. In the introductory speech on the ban on discard, the Commissioner not only talked of the fish as a food resource, but as a *critical* food resource. The Commissioner activated a threat where consumers might

stop buying fish as a moral response to the discarding problematic according to principles of sustainability. The speech made it explicit that fish was healthy food and that it contained vital substances not possible to substitute by eating other foods. But at the same time the fish was framed both as a limited and valuable resource and as common property. The Commissioner concluded her speech by appealing to the audience to clearly express their views, and that the reformation of fisheries policy is a process that must be created together. She set the direction of the continued argumentation by stating that (emphasis in original): “we must *together* abolish the idea that fish is an unlimited resource”. This is a rhetorical ‘we’ since the term is not qualified. Nevertheless, the inclusive use of language served to stress the social character of the problematic by making it a common responsibility. It is neither an issue for policy-makers nor for fishermen or consumers, but for everybody together. This was a crucial point to make explicit, since the creation of a market demands both producers and consumers.

By being defined as limited, fish was contextualized as a resource that can disappear. But a resource can also remain unexploited. A natural resource can be transformed from being a part of nature which is not utilized – not a resource but part of an ecosystem, just ‘fish’ – to a resource in a complex market system. This transformation implies that fish as a limited food resource, in contrast to fish not yet defined as resource, runs the risk of being overexploited and perhaps exterminated. Therefore, fish must be valorized. The process of valorization is necessary for policy to become legitimate. With valorization comes difference, not only in economic terms but also in moral ones. The appeal to a common ‘we’ becomes empty if it is not accompanied by value statements: “Unless we can distinguish better from worse states of the world then it makes no sense to try to achieve one state from among the alternatives. No value criterion, no responsibility, no need to think” (Daly, 2007, p. 194). Valorization and responsibility goes hand in hand.

## Fish as a common resource

The Commissioner pointed to a number of conditions surrounding the issue of discarding that made it central for the CFP. Her presentation of the whole problem with a failed fisheries policy rested upon the fact that certain fish is taken on board and then thrown over-board. She chose to conclude by expressing the problem as *threatening* in her formulation that fish is not an unlimited resource. A resource that is described as limited can be rhetorically contextualized as valuable, and the Norwegian minister connected to this (emphasis in original): “Seafood is a *valuable* resource and lately consumers have begun to make higher demands that fish should be sustainably fished”. In congruence with the Swedish minister’s statement, the problem was again framed by external demands from consumers and something that policy must respond to. The statement established that the arguments put forward stem from the market and future market constructions. These demands cannot be ignored. That they should be fixed in relation to the notion of fish as a common resource was made explicit by the Danish minister:

Fish is our common resource. For the industry the issue is to secure the access to the resource also for future generations. For consumers this is unanimous. They ask for sustainably produced fish. From the perspectives of the politicians this is also unanimous. I cannot accept that common resources are wasted.

The fish resource was defined through the rhetorical use of sustainability, where the process of sustainable production qualifies the value of fish so a market can be established and maintained. When the fish in this way was established as a common and critical resource, the issue of responsibility is consequently put on the agenda. But who owns the issue of responsibility? Who is included in ‘our’? An assumption in the argumentation was that consumers act through a market where they demand a certain product – sustainably produced fish. Policy makers on their part relate to consumers whom they must accommodate and



sustainability becomes the result of economics. The Danish minister referred to the industry in her statement but refrained from making it explicit what or whom the industry encompasses. In the statement from the Danish minister the issue of responsibility implicitly shifted between different stakeholders. This made it possible to talk of fish as a resource on a market without making the reference to the industry problematic. Instead, the problem was made all-encompassing and thereby vague.

In sum, the line of argumentation included a threat, explicit demands and it stressed significant consequences. Fish was framed as a resource, and a resource can be valorized when it is positioned on a scale from easily accessible to extinct in a context of sustainability and economic crisis. The transformation from fish to resource allows for a rhetoric technique where fish is a common resource (that everybody has responsibility for and which might become extinct) to fish as a resource for different stakeholders (which makes it valuable on a market). In the concluding remark from the Commissioner – “we must *together* abolish the idea that fish is an unlimited resource” – the rhetoric is powered by this double connotation attached to fish as food: the resource is limited and the subject for our common responsibility.

### **Market-making**

Talking about fish as a resource enables it to be activated in different discourses. We have demonstrated how the resource fish was qualified by a moral argument. Fish was placed in a discourse that abolished the waste of fish as food and defined as a limited natural resource. The problem was articulated in terms of waste also in an ecological context since discards result in a distorted estimation of the status of the resource since it is only possible to generate knowledge about it from landed catches. The problem was made multi-dimensional and therefore more urgent as a claim-making strategy for legitimacy and public support (Loseke, 2003).

The larger part of the RSAAF seminar was devoted to establish a solution to the multi-dimensional problem. The ministers argued that a total ban for all discards was necessary while the professional fishermen countered that a total ban results in new problems although a selective ban was acceptable. This argument demonstrated that to land all fish, including red-listed species and fish under minimum size for species that survive being thrown back, was a practice in conflict with their professional ethics. However, the professional fishermen were given little time at the seminar and their line of argumentation did not receive a response. The possible seminar outcome of letting different moral standpoints meet was not realized. The dominant discourse that took shape was structured around a moral that was bureaucratically derived rather than grounded in the practice-based moral of fishermen. When one of the fishermen suggested that instead of commercializing fish, it made moral sense to conserve it and send it to places with food shortages in the global South, this difference was made explicit.

By advocating a total ban on discards, policy-makers are faced with the issue of giving commercial value to fish that until now has not been a resource but only 'fish'. To the transformation from fish to food resource, the stage to *commercial* food resource must be added. This is a necessary conclusion to the moral argument that is wrong to waste food. The dominant morality emerging at the seminar needed a market to become operational. Part of the solution to the problem thus became to facilitate new consumer knowledge to power this market. In a real-time addition to the moral argument presented so far, a well-known and starred Swedish chef was given the word. His message was that we – as consumers – have an all too limited view of what is possible to eat. His authority made it clear that the public was ignorant in this regard. The rhetorical power in his presentation became the will to gain new knowledge and master the so far unknown underwater world. He educated the public, offering to be a guide to both the sea and the kitchen. His presentation served the double purpose of

not only making the commercializing new species of fish legitimate but also making these species exotic and symbolically attractive. The starred chef opened up a new commercial world where the commonly used cod were only a small part of the food resource. His narrative of the chain from sea to table was seductive and educational. By stating that “if you want something unique you cannot ask for the menu one month in advance”, he made the direct association between the ban on discarding and new norms for restaurant customers. Implicitly, the ban on discarding became attached with connotations of the symbolic capital of consumption.

In sum, in the RSAAF seminar social notions of an unlimited resource became the scapegoat that had allowed over-board discarding – and therefore the massive CFP failure – without serious moral implications. This was changing since the Commissioner mentioned “bad image about fishing” in this context, thereby objecting to a notion of a boundary-less world that she called “a faulty idea” while blaming policy makers and not fishermen. The problem was given a moral dimension because a world without boundaries lacks moral value foundations. This was an effective way of constructing the problem and point out how it could be solved. The complexity of the real world was held at bay by making a policy failure into a moral issue under a common responsibility. The conclusion to this line of argumentation was the creation of a new market for formerly non-commercial species of fish. During the process of articulating this market, fish was first morally and then symbolically charged. Fish became a potentially profitable resource in economic terms. But in order to realize the potential, a reformed CFP needs profitability at the level of individual firms. In the proposal this is operationalized through the annihilation of fleet overcapacity. The creation of a new market for fish is not enough to attain sustainable fisheries. Fish must also be made profitable for the individual firm. Through ITQ fish is valorized as an economic resource for individual fishermen, as the SCAB seminar illustrated.

## Economic valorization

The SCAB seminar on ITQ in relation to small-scale coastal fisheries included a range of stakeholders in fisheries governance but excluded professional fishermen. Early on in the seminar, an academic economist explained the rationale of transferrable quotas by accounting for the underlying modeling principles. From having been a possible political approach among other possible approaches, ITQ became established as a practice with theoretical and scientific legitimacy. The economics theorem that needed to be taken as a given for this to work was that for-profit businesses power societal development, and that it is profitable businesses that can act in a market economy. However, fish in itself is not a priori a part of a market system. Fisheries management can just as well build upon free access or non-market oriented political decisions. But the economist stated that fisheries lacked effective pricing mechanisms to allocate the resource. Here, ITQ was activated as a tool for sustainability in the unanimous statement that "ITQ create value". At almost every turn in the presentation the economist was challenged by a professional fisherman that – although no fishermen were invited – was there in the capacity of chairman of a stakeholder organization. The active reduction of social complexity performed by the economist was countered by the active introduction of social complexity performed by the fisherman.

The ITQ system depends upon the potential to quantify a resource where a ban on discards serves to give a reliable representation of the resource status, and allocate it to quotas. At the seminar fish was this resource, but other resources are possible, for example days-at-sea. Apart from making fish quantifiable, it must be associated with economic value. One way of valorizing fish in this way is to transform it into private property. ITQ do this by attaching quotas to individual fishing vessels. When ITQ was established as a legitimate resource allocation model at the seminar, fish became manageable in the economics model. What the economist did at the seminar was to posit that capital is able to generate profit only if it

circulates. Stagnant capital does not have the ability to power markets. Fish is mobile across administrative boundaries and difficult to control. The ban on discards helps to visualize the mobility of fish while ITQ regulates it.

The ITQ logic opened up for an additional interpretation of the moral argumentation that took shape at the RSSAF seminar. The principle behind ITQ is effectiveness. A less profitable fishing business can sell its quota to a more profitable business. The seller makes a profit and exits the fishery, while the buyer can optimize fishing profitability. If ITQ were to be unrealized, the situation would become defined by a form of reversed waste of resources; it would remain sub-effective. The economist represented the pre-ITQ situation as inflexible. Some fishermen fish their allocated quota early in the year, while others do not manage to fish their quota at all. The total quota on a regional or national level might thereby not be utilized optimally. By privatizing fish, the new market for ITQ would ensure that the maximum sustainable yield, whose estimation becomes possible through a discarding ban and the landing of all catches, is reached. ITQ was thereby represented as a solution to a situation with overcapacity but underutilization. The morality that was articulated at the RSSAF seminar then became an issue of effectiveness, and moral grading was associated with degree of optimization. The economics modeling that a reformed CFP is conditional upon was transformed into moral modeling with the help of the principle of efficiency. This was only one possible outcome. Alternative outcomes could for example have been grounded in principles of sufficiency and frugality rather than efficiency, including in the discourse the risk of ending up “consuming more of the resource than before, albeit more efficiently” (Daly, 2007, p. 193).

At the SCAB seminar, the representative from the Board itself suggested that low profitability is not in itself wrong. He posed the rhetorical question “What do we as owners of the quota want?” and answered “It seems as if we should manage the small-scale”. Whether ITQ is the

proper way to do this was not taken to a conclusion at the seminar. Instead, it ended with the open question of responsibility for the continued dialogue about ITQ, by now established as legitimate fisheries management alternative. The Board representative concluded by returning to the economics model on which ITQ is based, and asked if there might be alternative models or if the model could be “adjusted” in different ways. In light of how the model had proved to be a highly contested issue, he could have added “in order to make it more compatible with social reality”.

## Conclusions

In sustainability discourse, ecological and economic aspects are often taken for granted and used as black-boxed qualities that policy is articulated and operationalized against (Hultman & Corvellec, 2012). Contrary to such an assumption, this study has shown how sustainability is socially constructed by the rhetorical mobilisation of particular orders of justification. We draw three conclusions from the analysis.

The first conclusion is that the social constructivist approach has made it possible to show how sustainability is a process whose meaning emerge in discursive practice (Figure 1).

FIGURE 1 NEAR HERE

The analysis revolved around the framing of fish as ‘resource’. At the RSAAF seminar on a proposed ban on discarding, fish was established as a critical food resource under a common responsibility. This allowed a moral argument that became associated with new markets and consumer demands for sustainable practices. The morally charged fish resource became the subject for economic valorization at the SCAB on ITQ in relation to small-scale coastal fisheries. By removing the social realities of the profession of small-scale fisheries from fishing rights associated with individual fishing vessels, a market for professional practices was legitimized and represented as the solution to a moral problem. Sustainability was

socially constructed through the imagining of new markets for (1) formerly non-commercial species of fish and (2) for the rights and competence to catch and land fish.

The second conclusion follows from this line of argument. Taken together, the two seminars posed the question: What is necessary to reestablish a moral order? The answer that emerged during the presentations and discussions was: Economics. This is an illustration of how economic growth, on a general level, is a primary order of justification in EU environmental policy. This is consequential since it raises the question of the measurability of sustainability parameters (Alexander, 2005) in relation to the experience, ethics and competence of professional fishermen. The market for ITQ is predictive because the model it builds upon has ambitions to fulfil its own criteria for success by ordering social reality according to the measurability it needs as input. In this way, the economic modelling that a reformed CFP relies on is self-fulfilling. This causal connection between economics and economies is not necessarily problematic or destructive, but it needs reflection among stakeholders involved in small-scale coastal fisheries.

This leads to the third conclusion. Fish was framed as a resource whose future status was a common responsibility. As the analysis has demonstrated, this responsibility was articulated in relation to the creation of new markets. This has consequences for how the responsibility must be understood since it becomes impossible to assume any part of this responsibility without being a part of the imagined markets. If policy, according to the neoliberal logic that governs the privatization of a natural resource to individual firms, has the function to set the conditions for a functioning market, the responsibility for the fish resource is shared between producers and consumers. A structuring principle in the proposal for a reformed CFP is that fishermen should assume control over a larger part of the value chain in transforming fish from natural resource to commodity. This is the meaning behind representing the CFP as a driving force behind the development of coastal communities. One possible interpretation of

this is that fishermen should take responsibility by developing their economic rationality as producers. As both the seminar made clear, this might not necessarily correspond to the professional ethics and moral values of professional fishermen.

## References

Alexander, C. (2005), Value: economic valuations and environmental policy, in Ed. J. Carrier, *A Handbook of Economic Anthropology* (Cheltenham: Edward Elgar).

Boltanskli, L. & Thévenot (1999), The Sociology of Critical Capacity, *European Journal of Social Theory*, 2, pp. 359-377.

Callon, M. (1998), Introduction: the embeddedness of economic markets in economics, in Ed. M. Callon, *The Laws of the Market* (Oxford: Blackwell).

Czarniawska, B. (1993), *The Three-Dimensional Organization: A Constructionist View* (Lund: Studentlitteratur).

Daly, H. (2007), The ‘illths’ of nations and the fecklessness of policy: an ecological economist’s perspective, in Ed. E. Fullbrook, *Real World Economics. A Post-Autistic Economics Reader* (London: Anthem Press).

EC (undated), *The Social Dimension of the CFP Reform*, retrieved 2012-04-23 at <http://ec.europa.eu/fisheries/reform>.

EC (2011a), *Regulation of the European Parliament and of the Council on the Common Fisheries Policy*, COM(2011) 425 final (Brussels: EC).

EC (2011b), *Impact Assessment Accompanying Commission Proposal for a Regulation of the European Parliament and of the Council on the Common Fisheries Policy*, SEC(2011) 891 (Brussels: EC).



EC (2011c), *Reform of the Common Fisheries Policy*, COM(2011) 417 final (Brussels: EC).

EC (2011d), *Regulation of the European Parliament and of the Council on the Common Organisation of the Markets in Fishery and Aquaculture Products*, COM(2011) 416 final (Brussels: EC).

Fleetwood, S. (2007), Why neoclassical economics explains nothing at all, in Ed. E.

Fullbrook, *Real World Economics. A Post-Autistic Economics Reader* (London: Anthem Press).

Fourcade, M. (2011), Price and Prejudice: On Economics and the Enchantment (and Disenchantment) of Nature, in Eds. J. Beckert & P. Aspers, *The Worth of Goods: Valuation and Pricing in the Economy* (Oxford: Oxford University Press).

Graeber, D. (2001), *Toward an Anthropological Theory of Value. The False Coin of Our Own Dreams* (New York: Palgrave).

Hultman, J. & Corvellec, H. (2012), The European waste hierarchy: from the socio-materiality of waste to a politics of consumption, *Environment and Planning A*, forthcoming.

Höjrup, T. (2011), *The Need for Common Goods for Coastal Communities* (Gylling: Narayana Press).

Kuttner, R. (1999), *Everything for Sale* (Chicago: The University of Chicago Press).

Loseke, R. D. (2003), *Thinking about Social Problems* (New York: Aldine de Gruyter).

McClanahan, T., Castilla, J. C., White, A. & Defeo, O. (2009), Healing small-scale fisheries by facilitating complex socio-ecological systems, *Reviews in Fish Biology and Fisheries*, 19, pp. 33-47.

Missimer, M., Robèrt, K-H., Broman, G. & Sverdrup, H. (2010), Exploring the possibility of a systematic and generic approach to social sustainability, *Journal of Cleaner Production*, 18, pp. 1107-1112.

Potter, J. (1997), *Representing Reality. Discourse, Rhetoric and Social Construction*. (London: SAGE).

Siler, K. (2007), The social and intellectual organization and construction of economics, in Ed. E. Fullbrook, *Real World Economics. A Post-Autistic Economics Reader* (London: Anthem Press).

Spaargaren, G. & Mol, A. (2009), Sociology, environment and modernity: ecological modernization as a theory of social change, in Eds. A. Mol, D. Sonnenfeld & G. Spaargaren, *The Ecological Modernization Reader. Environmental Reform in Theory and Practice* (London: Routledge).

Wenneberg, S. (2001), *Socialkonstruktivism – positioner, problem och perspektiv*. (Malmö: Liber).

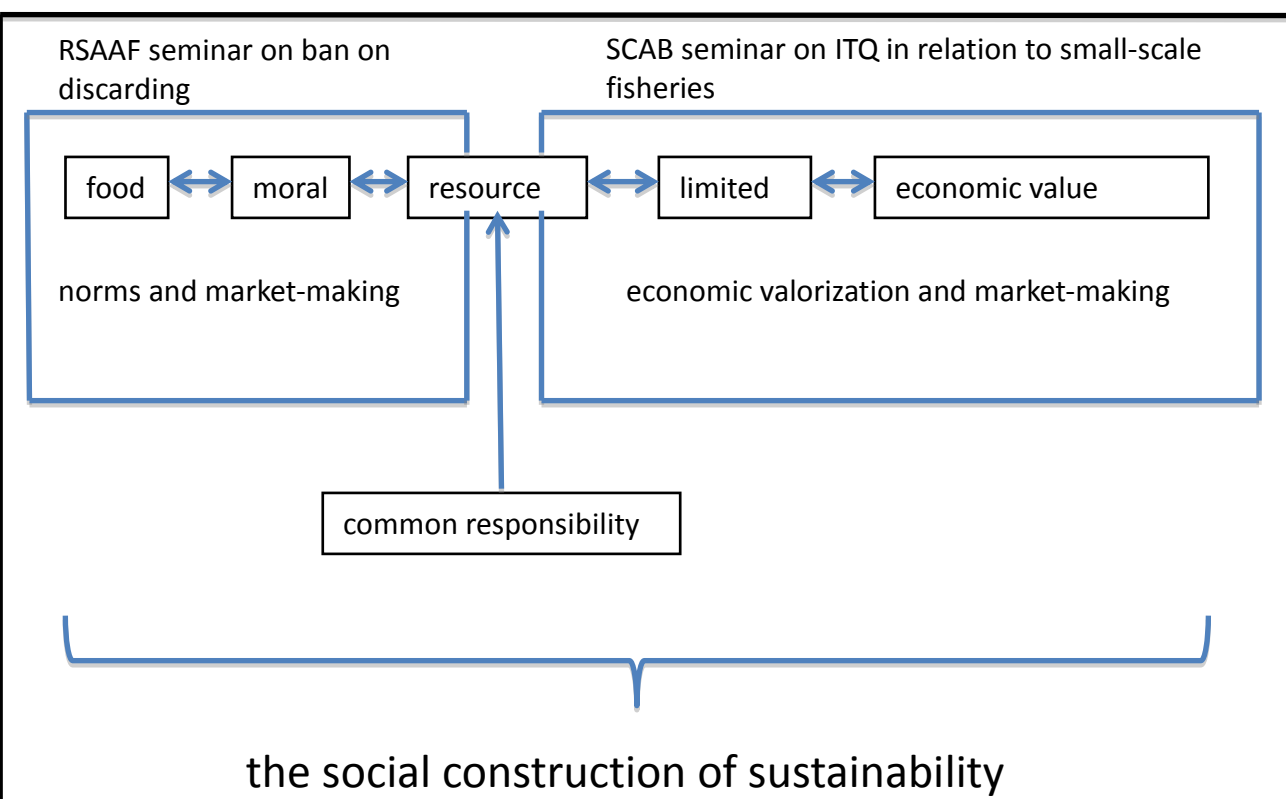


Figure 1. The social construction of sustainability in two seminars on the proposal for a reformed EU Common Fisheries Policy.

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[1c: Beyond 'sustainability': (re-)defining and institutionalisation of sustainability]

**Identification of Key Fields of Sustainability Practices and  
Operational Criteria for Sustainable Development**

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**Abstract**

The terms 'sustainability' and 'sustainable' in the context of sustainable development (SD) can often be found in mass media as well as on Internet today. Although these terms have attracted people, their meanings are still vague. This study explored how the terms were used, what was intended to be 'sustained' in each usage, and what kind of concrete criteria was used. First, we searched for 'sustainable' in Japanese and English newspapers and observed increasing trends of the use of the term. Secondly, we searched for 'sustainable xxx' in Web pages and identified that key fields of SD practices and activities. Finally, we reviewed SD criteria set by several activities and documents around the world. After reviewing 12 sets of SD criteria, we categorized those criteria into 10 subgroups and integrated them into three groups: reversibility, human needs, and stability.

**Introduction**

The concept of sustainable development (SD) was developed in the late 1980s. The most famous definition is that of the Brundtland Commission in *Our Common Future* (World Commission on Environment and Development, 1987): 'development that meets the needs of the present without compromising the ability of future generations to meet their own needs'. The concept of SD became popular from the late 1980s to 1990s. Many different definitions of SD were proposed. The terms 'sustainability' and 'sustainable' in the context of SD can often be found in mass media

as well as on Internet today. Barkemeyer et al. (2009) investigated the frequency of the use of ‘sustainability’ and ‘sustainable development’ as well as ‘Corporate Social Responsibility,’ etc. in 115 newspapers published between 1990 and 2008 from 39 countries, and identified the increasing trend of the use of ‘sustainability’ and ‘sustainable development’. Kajikawa et al. (2007) observed another increasing trend for scientific papers in journals. Kates et al. (2005) found 8,720,000 Web pages that used ‘sustainable development.’ Although these terms have attracted people’s attentions, their meanings have been vague. Several studies tried to clarify the meanings of ‘sustainable development.’ For instance, Morita, T. and Kawashima, Y. (1993) reviewed and categorized 41 definitions of ‘sustainable development’ in articles published in years between the late 1970s and the early 1990s, and identified three key components to define ‘sustainable development’: (1) conservation of ecosystem and natural resources, (2) inter-generational equity, and (3) intra-generational equity and poverty reduction. The core definition and meaning have become clearer on conceptual level, however, these are still too abstract to use in increasing/expanding activities relating to sustainable development and to deepen constructive discussions on sustainable development. In addition, different framing of issues has caused gaps between stakeholders’ perception on the issues. Meanwhile, especially for the last decade, the concept of SD has spread to various areas relating to SD. This can be regarded as a shift from concept to practices in terms of SD, and we could learn practical wisdoms on SD from such practices.

This study therefore explored what are intended to be sustained in each usage, and what kind of criteria should be used for the meanings of the term, focusing on various practices about SD and examined the above-mentioned conceptual points.

## **Methodology**

### *Trend in the use of ‘sustainable’ in Japanese newspapers*

The study by Barkemeyer et al. (2009) covered 115 newspapers from 39 countries but excluded Japanese newspapers. We therefore investigated the trends in the use of ‘sustainable’ in the five major Japanese newspapers (Yomiuri, Mainichi, Asahi, Nikkei, and Sankei) mainly, and in the New York Times and the Guardian to see if there were any trends in Japanese media that were different from Western media. We then compared them with the trend that Barkemeyer et al. (2009) identified.

In Japanese, ‘sustainable’ is represented in four different terms, “*jizoku-kanou*”, “*sustainable*”, “*sustInable*”, and “*sustEnable*,” which are found in newspapers,

scientific articles, and Web sites written in Japanese (Hereinafter, these four terms are referred to as “‘sustainable’ in Japanese”). We searched these four terms in Japanese newspapers and ‘sustainable’ in the other two newspapers written in English. The period for our investigation was from 1990 to 2011.

We initially tried to conduct the same search on the Web. However, as the number of websites themselves had increased rapidly, we found it difficult to tell whether increasing trend in the use of the terms was due to increase in the number of websites, or increase in the people’s concern for ‘sustainability’. Thus, we decided not to search on the Web.

#### *Identification of words associated with ‘sustainable’ on the Web*

Next, we searched words following after ‘sustainable’ (Hereinafter, referred as “associated words” or “words associated with ‘sustainable’”) for the Web. The reason why we chose the Web for the survey was because information obtainable on the Web included newspapers, books, and other journals and was the largest source of information. We used Google search engine to search ‘sustainable’ in Japanese and English. As Google showed 1,000 Web pages at maximum, we extracted associating words from 1,000 Web pages. The search was conducted between March and April 2012. We also surveyed the number of hits for the phrases of “sustainable xxx” (“xxx” is an associated word.) by using Google’s phrase search mode. Several phrases were searched for different years between 1990 and 2010. The extracted words were compared with the results of a review on national SD indicators conducted by Tasaki et al. (2010), which covered 28 national indicator sets.

#### *Review and categorization of criteria for sustainable development*

Finally, we reviewed SD criteria set by several activities and documents around the world as a preliminary survey. Twelve sets of criteria were chosen: Harman Daly’s operational principles (1990), Natural Step’s four systems conditions (Robèrt, K.-H., 1997), Oreccini’s Energy sustainability pillars (2009), the Cramer criteria (Project group Sustainable production of biomass, 2006), principles of sustainability by U.S. President’s Council on SD (1995), Fukushima’s conditions of sustainability (2006), OECD Environment Council’s conditions of sustainable agriculture (1993), MSC (Marine Stewardship Council, 2002), FSC (Forest Stewardship Council, 1999), Global Partnership for Sustainable Tourism Criteria (2008), five elements in “another development” (Nerfin, 1977), and sustainable community indicator checklist (Sustainable Measures). We categorized these criteria into subgroups (referred as

“common criteria”) and integrated them into criteria groups, and then applied the framework of the groups and subgroups to phrases found in the previous part of this study (e.g., sustainable agriculture). The application was conducted in a rather subjective way that we reflect upon what concrete criteria can be obtained when a common criterion is applied to ‘sustainable \*\*\*’ and what can be required for the ‘sustainable \*\*\*.’

## Results

### *Trend in the use of ‘sustainable’ in Japanese newspapers*

Figure 1 shows the number of the hits of ‘sustainable’ in newspapers. All of them indicated increasing trends. The number of the hits became relatively large in the 2000s or shortly before the year 2000. In the data of Japan between 1990 and 2011, there were two peaks in 1992 and 2002, when the Earth Summits (Rio de Janeiro and Johannesburg) were held. It should be noted that the number of hits after the peak did not return to the level of the previous year (The numbers showed a net increase even several years after the peak). This suggests increased public attention to SD.

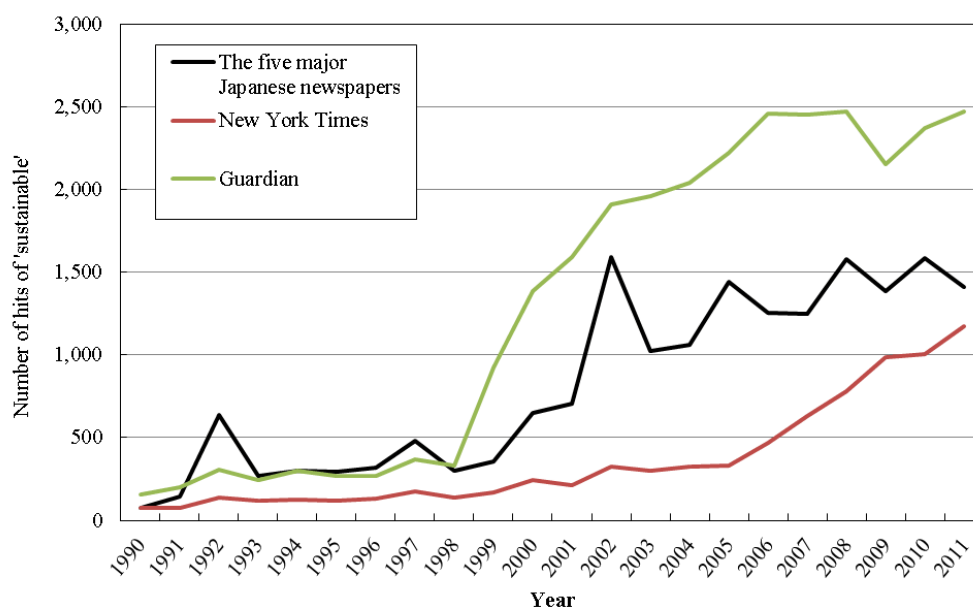


Figure 1 Trends of the number of hits of ‘sustainable’ for newspapers written in Japanese and English since 1990.

To compare the trend of Japanese newspapers with the results of the trends investigated by Barkmeyer et al. (2009), we calculated the number of hits per newspaper issue (Data

of Barkmeyer et al. (2009) is on a monthly basis while our original data was on an annual basis. In Japanese, ‘sustainable (*jizoku-kanou*)’ includes ‘sustainability (*jizoku-kanou-sei*)’ when searched). Figure 2 shows a similar trend in Figure 1 that the numbers of hits since 2000 were relatively large, there were two remarkable peaks in 1992 and 2002, there was a slight peak in 1997 when the Kyoto Protocol was adopted.

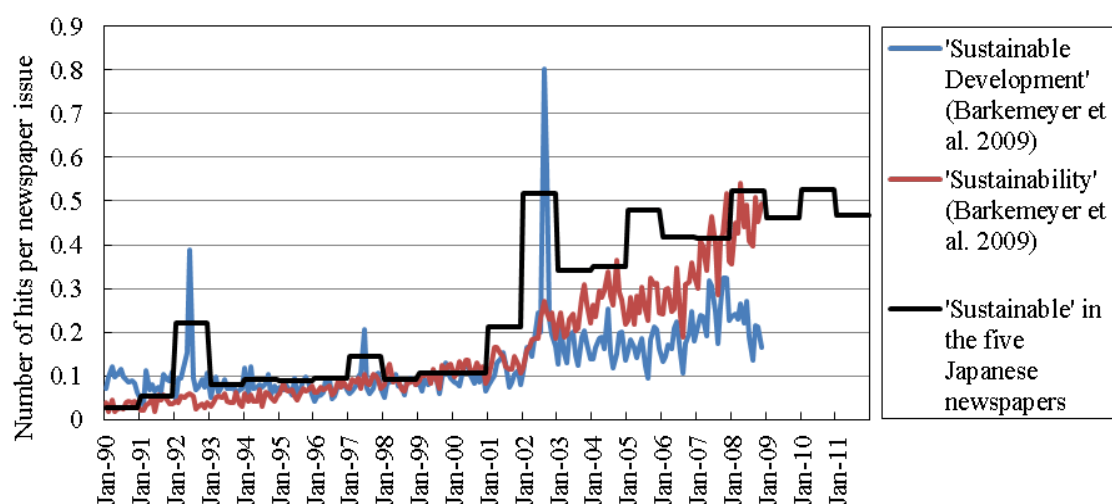


Figure 2 Comparison of the number of hits of ‘sustainability’ per newspaper issue.

The difference was additional three peaks observed in the 2000s in the Japanese data. One was in 2005 when the Kyoto Protocol was enforced. Another was in 2008 when the G8 Lake Toya Summit was held in Japan. The other was in 2010 when COP 10 to the Convention on Biological Diversity was held in Nagoya, Japan. The latter two peaks did not result in a net increase.

#### *Identification of words associated with ‘sustainable’ on the Web*

Various words associated with ‘sustainable’ in English and Japanese were found on the Web. Table 1 shows top-15 phrases.

In Japanese, associated words were those having relatively broader meanings. In contrast, more concrete words were used with ‘sustainable’ in English. In addition to the associated words in Table 1, we identified the following words: *sustainable consumption, sustainable culture, sustainable design, sustainable fashion, sustainable fishery, sustainable forestry, sustainable industry, sustainable innovation, sustainable land use, sustainable lifestyle, sustainable production, sustainable resource, sustainable supply chain, and sustainable technology, etc.*

Table 2 shows major categories extracted from 77 categories that were identified by Tasaki et al. (2010) who reviewed 28 national SD indicators. These are



deemed as important categories of SD that a society should be aware of. Words with a negative connotation concerning SD (e.g., climate change, waste generation, and poverty) drew attention from society, but were not associated with ‘sustainable’. This can be both advantageous and disadvantageous for the approach of identifying words associated with ‘sustainable.’ The approach cannot cover all issues concerning SD, but will empirically reveal what to be sustained.

Table 1 Words associated with ‘sustainable’ on the Web  
in Japanese and English.

Japanese	No. of hits <sup>a)</sup>	English	No. of hits <sup>a)</sup>
Job	1,610,000	<b>community</b>	18,420,000
<b>economy</b>	1,570,000	<b>management</b>	17,700,000
event	1,190,000	<b>energy</b>	12,200,000
<b>energy</b>	1,120,000	agriculture	10,300,000
environment	1,050,000	<b>living</b>	9,250,000
product	1,040,000	design	8,510,000
information	1,020,000	tourism	8,050,000
<b>life</b>	975,000	transport	6,210,000
<b>enterprise</b>	952,000	<b>business</b>	5,930,000
<b>region</b>	912,000	building	5,900,000
society	910,000	food	4,930,000
action	831,000	city	4,850,000
finance	823,000	farming	4,200,000
<b>management</b>	793,000	water	3,500,000
<b>market</b>	734,000	architecture	3,380,000

**Bold:** the same or very similar words between Japanese and English.

a) No. of hits: Searched by Google’ phrase search mode.

Table 2 Major indicator categories of 28 national sustainable development (SD)  
indicators, retrieved from Tasaki et al. (2010).

	Environmental	Economic	Social
Indicator category that more than two thirds of countries adopted	“Climate change”, “Air quality”, “Water quality”, and “Ecosystem”	“Economic performance”, “Capital and investment”, “Energy use”, “Transportation”, and “Waste generation and management”	“Work”, “Mortality, life expectancy, and health”, “Education”, and “Poverty and dependence”
Indicator category that more than half and less	“Agriculture and livestock”, “Chemicals”, “Soil”, “Land use”,	“Financial status”, “Trade”, “Material use”, “Recycling”, and “Eco-business”	“International cooperation”, “Housing”, “Gender inequality”,

than two thirds of countries adopted	“Endangered species”, “Forest”, and “Water quantity”		“Economic inequality”, “Information”, and “Culture, leisure, and time”
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We placed these phrases with associated words in a hexagonal framework of SD indicators shown in Figure 3, which consists of the three pillars of environment, economy and society and the three combinations between any of two pillars and has a hierarchy of individual and national indicators for SD in each six triangular domain (Tasaki et al. 2009). The results are shown in Figure 4. As mentioned earlier, words with a negative connotation concerning SD are not associated with ‘sustainable.’ Also, (almost) no words were found in the triangle of ‘Society and economy’ at the bottom. On contrary, many words associated with ‘sustainable’ were placed in the triangles of ‘Environment and economy’, ‘Economy’, and ‘Society and environment.’ We interpreted the results as follows: (1) The current economy is perceived as unsustainable, and therefore many associated words addressed the ‘economy;’ and (2) The environment should be sustainable but emphasis is put on relationships between environment and human activities (‘Sustainable’ does not mean environmental conservation but a balancing of human activities and environmental conservation).

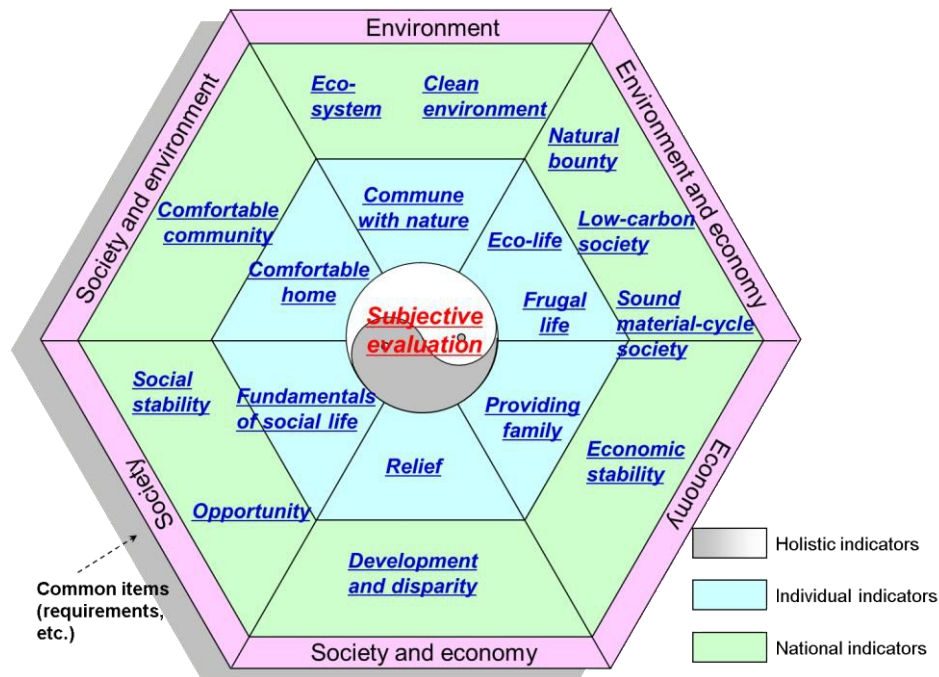


Figure 3 A hexagonal framework of SD indicators (Tasaki et al. 2009).

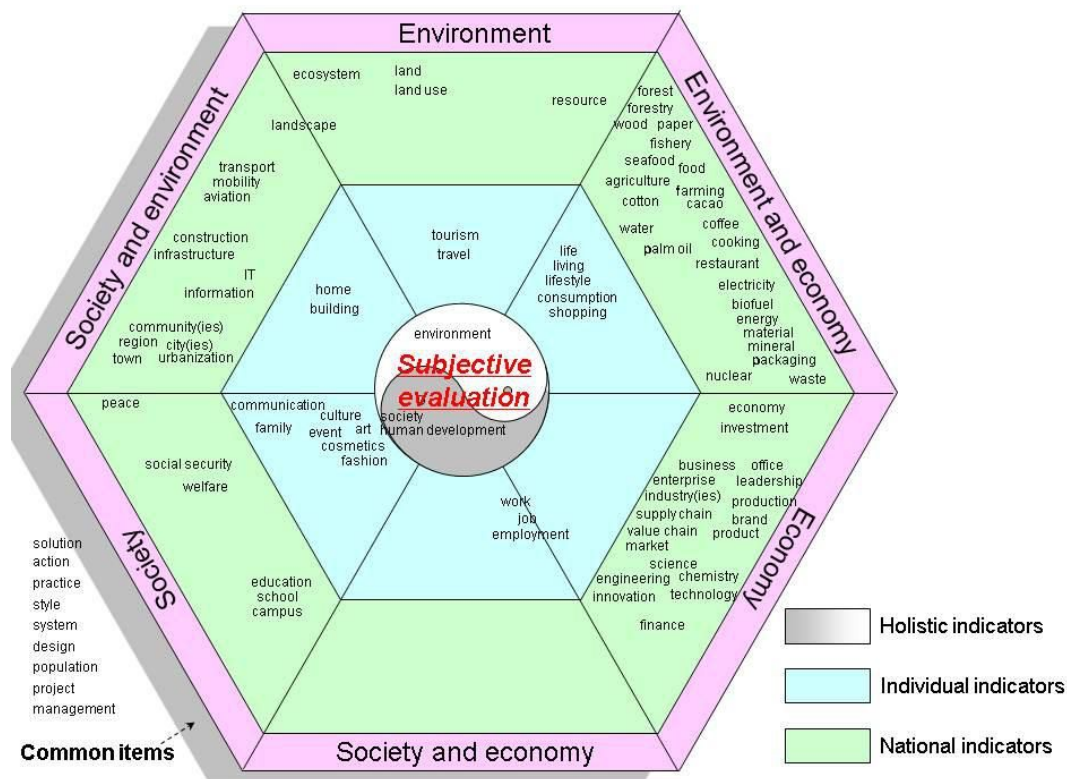


Figure 4 Words associated with 'sustainable' searched by using Google's phrase search mode, placed in the hexagonal framework of Figure 3.

Out of the previously searched words associated with 'sustainable', we selected several words and checked the number of hits for those words in five-year periods from 1990 to 2010. As Figure 5 shows, the number of hits for all those words has been increasing but the timing of popularity differs. *Sustainable agriculture*, *sustainable energy*, and *sustainable management* were already fairly used in the 1990s, while *sustainable community* and *sustainable economy* were not used as frequently in the early 1990s. (Note that Google mentions that the search option by the publication date works best for pages published after 2001. The numbers of hits for 1990 and 1995 are less reliable.)

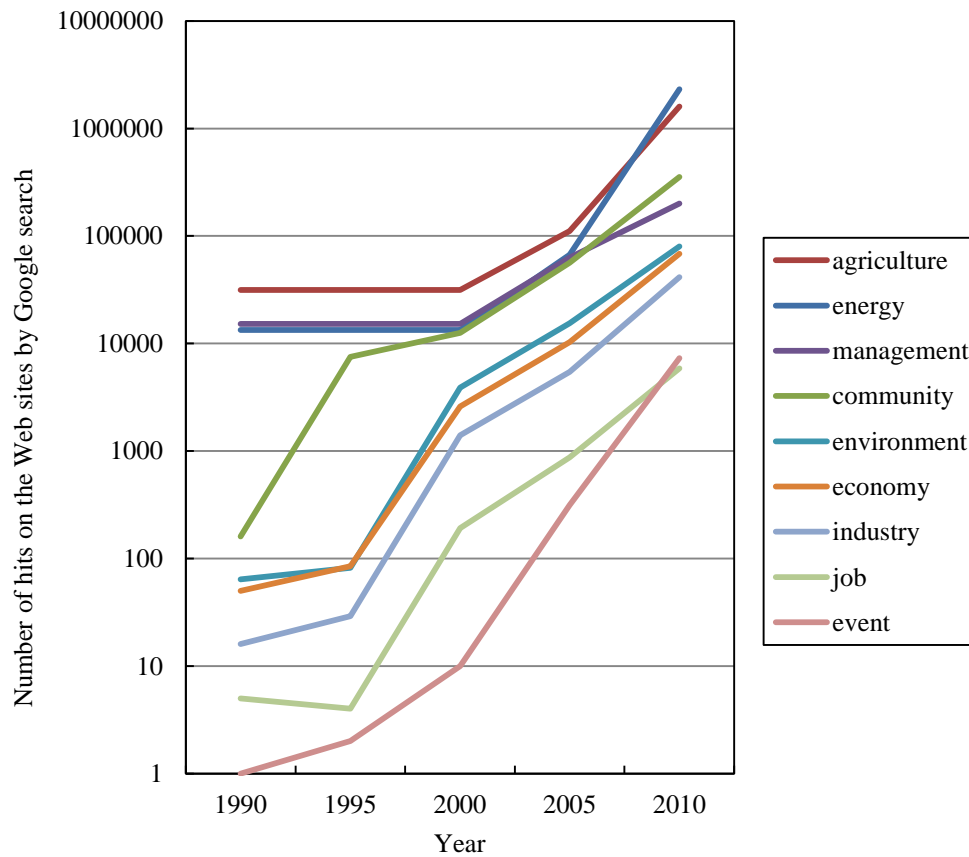


Figure 5 Trend of the use of several words associated with ‘sustainable’ from 1990 to 2010.

#### *Review and categorization of criteria for sustainable development*

We reviewed and categorized/generalized 12 SD criteria in literature into 10 common criteria and integrated them into three criteria groups: 1) reversibility, 2) human needs, and 3) stability as shown in Table 3. At first (after the literature review on SD criteria), the subcriteria 1-d) and 2-e) were placed in the Criteria Group 2 as criteria, and common criteria 2-a), 2-c) and 2-d) did not exist. These were relocated or added through our trial application of the criteria to *sustainable agriculture*, *sustainable forestry*, *sustainable fishery*, *sustainable tourism*, *sustainable land use*, *sustainable energy*, *sustainable resource use*, and *sustainable chemical use*. The criteria shown in Table 3 are still tentative as we did not review various criteria fully nor examined their validity. We assumed that the criteria reviewed were feasible, leaving validation of these criteria to be a future task.

The first group of SD criteria, reversibility, is related to “what needs to be sustained” while the second group, human needs, is related to “what to be developed.”

The third group, stability, seemed different from the others and originating the indeterministic and unpredictable nature of the world. If people think we understand the world with certainty, the importance of criteria in the third group would decrease. In other words, selection of the SD criteria more or less depends on how people see their world. This can also be said to the second group. Human needs change as a society develops. The relative importance of criteria in the second group thus can be changed as a society develops.

We found that several criteria should be distinguished as subcriteria. For instance, increase in efficiency of the use of resources is related to criteria 1-a) and 1-c). But if a current situation of a society meets these criteria, the society does not have to increase efficiency of the use of resources. Using such a subcriterion is rational only when its supercriterion is not achieved. As subcriteria seemed to be more concrete and operational, wise use of subcriteria can probably enhance effectiveness of activities for SD. However, misunderstanding of a sub-criterion as a criterion could delay the progress in activities towards SD, distracting us from a genuine criterion that should be taken into account. In this sense, we have to distinguish subcriteria from criteria and use subcriteria appropriately. Further verification of the tentative SD criteria and clarification of the structure of common SD criteria remains as a future task.

Table 3 Tentative SD criteria created through literature review and application

Criteria group	Common criteria	
1. <b>Reversible;</b> otherwise, substitutable or can be mended	a) Natural regeneration rate $\geq$ Consumption of resources and nature	d) Efficient use [to reduce the right side]
	b) Assimilation rate $\geq$ Release of pollutants	
	c) Substitution/artificial regeneration rate of resources and nature $\geq$ Consumption of resources and nature	
2. <b>Meeting basic human needs,</b> and <b>advanced</b> human needs according to the phase of development	a) Ensured safe life (Existence, health, property, etc. are not spoiled significantly)	e) Diversity of choices
	b) Equitable accesses to resources/nature	
	c) Continuity of socially-required activities and societal stocks	
	d) Various needs to be met holistically	
3. More <b>stable</b> (incl. retained succession)	a) Sufficient controllability	
	b) Preventive measures taken, or prepared	
	c) Fail-safe mechanisms	

## Conclusion

In this study, we revealed increasing trends of the use of the term *sustainable* in English and Japanese from 1990 to 2011. We also identified various words associated with *sustainable*, “sustainable xxx,” on the Web and discussed characteristics of the use of these associated words. Investigating the use of the words would help understand state of activities/practices towards SD. Moreover, we categorized SD criteria into 10 common SD criteria with three criteria groups. Although our examination is still on the way, we can conclude that understanding of the structure of these SD criteria is one of important task in the scientific fields of SD. Reviewing SD criteria in each individual activity/practice for SD, including different words associated with *sustainable*, would help formulate the idea of both operational SD criteria, which are readily available for various activities, and common, conceptual SD criteria, which built a foundation of sustainability science.

## Acknowledgement

We acknowledge Dr. Ralf Barkemeyer, Queen’s University Management School, UK, who kindly provided us with their data, which were used in this study. We conducted categorization of SD criteria in cooperation with Nobuo Shirai and Shumpei Shimada from PREC Institute Inc. We sincerely acknowledge them as well.

## References

- Barkemeyer, R., Figge, F., Holt, D., and Hahn, T. (2009) What the Papers Say: Trends in Sustainability - A Comparative Analysis of 115 Leading National Newspapers Worldwide. *Journal of Corporate Citizenship* 33(Spring), 69-86.
- Daly, H. E. (1990) Toward some operational principles of sustainable development. *Ecological Economics*, 2 (1), 1-6.
- Fukushima (2006) Conditions of sustainability. *Environmental Science*, 19 (5), 415-424 (in Japanese).
- The Global Partnership for Sustainable Tourism Criteria (2008) (<http://www.sustainabletourismcriteria.org/criteria-version-4.html>)
- Kates, R. W., Parris, T. M., and Leiserowitz, A. A. (2005) What is Sustainable Development? Goals, indicators, values, and practice. *Environment*, 47(3), 9-21.
- Kajikawa, Y., Ohno, J., Takeda, Y., Matsushima, K., and Komiyama, H. (2007) Creating an academic landscape of sustainability science: an analysis of the citation network. *Sustainable Science*, 2, 221-231.

Morita, T. and Kawashima, Y. (1993) Study on Definitions and Indicators for Sustainable Development: Trends and Remaining Work [in Japanese]. Mita Journal 85(4) 4-33.

Nerfin, M. (ed.) (1977) Another development: approaches and strategies. Dag Hammarskjöld Foundation.

OECD (1993) Agricultural and Environmental Policy Integration: Recent Progress and New Directions, Paris, France.

Orecchini F. (2009) Energy Sustainability in the framework of Sustainability Science. Sustainability Transition, RISS/IR3SW/SDC International Conference, Osaka, pp. 18-20

Project group Sustainable production of biomass (2006) Criteria for sustainable biomass production. Final report of the Project group 'Sustainable production of biomass'

Robèrt, K.-H. (1997) The Natural Step – A Framework for Achieving Sustainability in Our Organizations. Pegasus Communications, Inc. 15p.

Sustainable Measures. Sustainable community indicator checklist (<http://www.sustainablemeasures.com/node/94>, accessed 2010.4.15)

Tasaki, T., Kameyama, Y., Hashimoto, S., Matsuhashi, K., Moriguchi, Y., and Harasawa, H. (2009) National Sustainable Development Indicators (SDI) and a National SDI Database and Framework. RISS/IR3S/SDC International Conference on Sustainability Transition, Proceedings, 123-126.

Tasaki, T., Kameyama, Y., Hashimoto, S., Moriguchi, Y., and Harasawa, H. (2010) A survey of national sustainable development indicators. International Journal of Sustainable Development, 13(4), 337-361.

U.S. President's Council on Sustainable Development (1995) Vision Statement and Principles

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**1. Title of the paper:**

Perspectives on Sustainability Assessment: An Integral Approach to Historical Changes in Social Systems and Water Environment in the Ili River Basin of Central Eurasia, 1900-2008

**Track 2a**

**ABSTRACT**

This paper proposes an alternative approach in sustainability assessment. The conceptual framework was developed by modifying Ken Wilber's All Quadrants, All Levels (AQAL) approach, and focuses on the inter-relatedness/inter-connection of various perspectives inherent to the concept of sustainability. To look at how our framework can facilitate the practice of sustainability assessment, we apply the framework to examine the relationship between social systems and the environmental changes in the Ili River basin across the period 1900-2008. This approach enables us to investigate the environmental problems of the Ili River basin in a 4-quadrant framework, and combine the empirics of quadrants obtained from traditional disciplinary methodologies.

The 4-quadrant framework adopted in this study illustrates the interlocking relationships among various perspectives of environmental issues in the Ili river basin, namely, physical perspective, personal perspective, cultural perspective and social perspective. In particular, the protruding development (evolution) of the lower right dimension is the fundamental cause of the environmental degradation and its related social problems in the Ili River basin. Compared to other established approaches in literature which emphasize on the trade-offs of various perspectives of sustainability, our findings indicate the potential contributions of 4-quadrant framework to sustainability assessment through its focus on the inter-relatedness/inter-connection of different perspectives.



**Keywords:** sustainability assessment, AQAL, water resources, agricultural development, the Ili River basin

## 1. Introduction

Sustainability assessment is increasingly viewed as an important tool to aid in the shift towards sustainability (Pope *et al.*, 2004). The diverse understanding of sustainability and sustainable development has led to different approaches to sustainability assessment. This study proposes an alternative approach in sustainability assessment, and applies it to a case study of the Ili River basin. Compared to other competitive approaches based on “three pillars”, our framework does not promote trade-offs between various factors inherent to the concept of sustainability. Instead, it emphasizes on the inter-relatedness/inter-connection of them. It is worthy to note that we analyze our case study empirically using well-established methodologies of different disciplines including hydrology, economics, geography and anthropology. The integrative framework proposed in this study is a conceptual scheme which attempts to generate interpretations encompassing the existing disciplines.

Our approach is based on Ken Wilber’s All Quadrants, All Levels (AQAL) approach, in particular, 4-quadrant framework which incorporates physic, personal, cultural and social systemic knowledge. In particular, our 4-quadrant framework highlights two spheres in the Kosmos, namely, the anthroposphere and the hydrosphere. Various components related to water environment problems in the Ili River basin are placed into the two spheres as well as the four quadrants to discuss the intrinsic dependence of these two spheres.

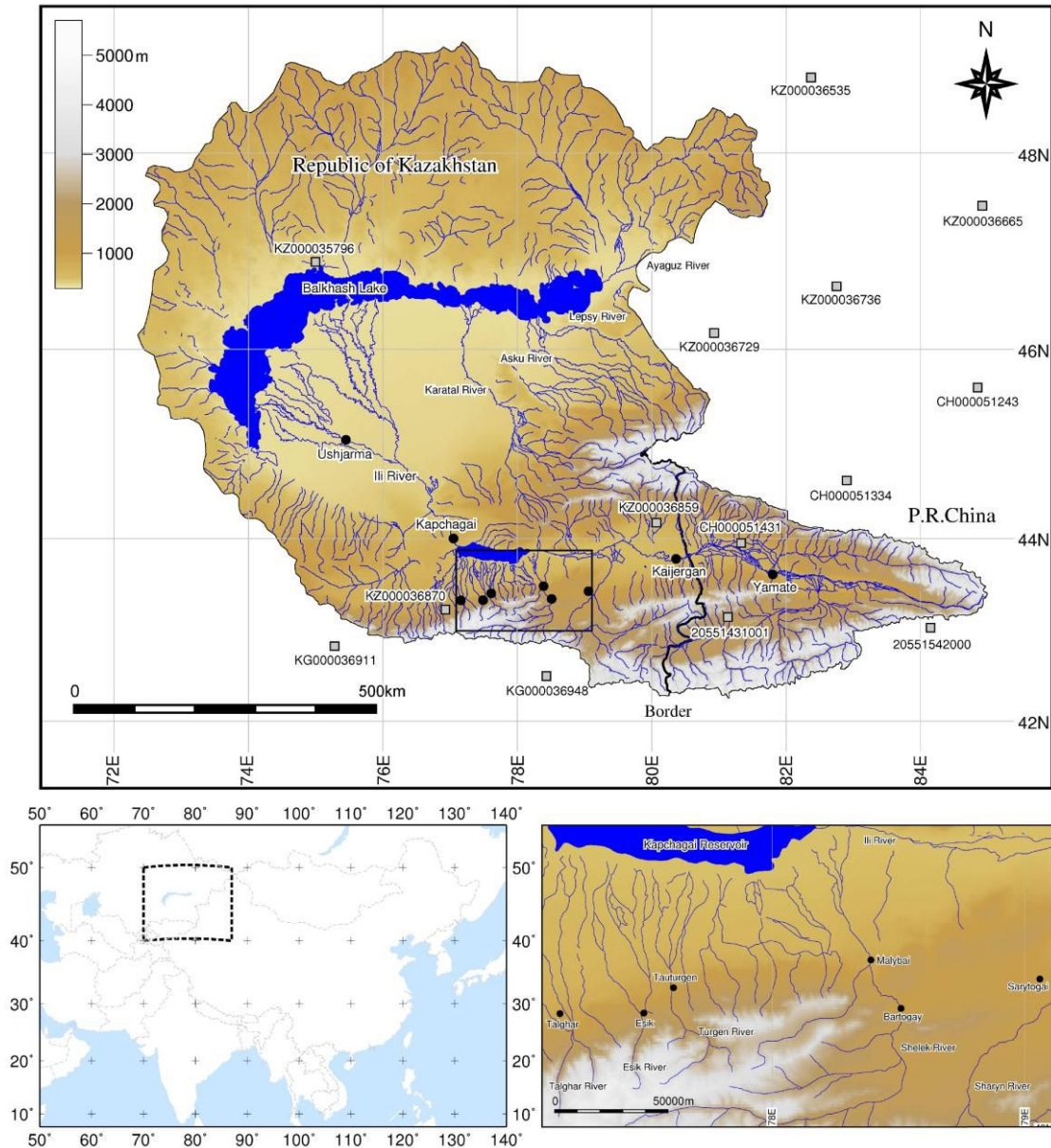
We choose the Ili River basin as study area because the region experienced two radical social changes in the 20th century, and therefore comprises of a good example to investigate the relationships between social systems and environmental changes from multiple perspectives. The Ili River basin is one of the vast inland river basins located in the arid and semi-arid regions of central Eurasia. Historically, nomadic pastoralism, i.e., people moving across pastures, constituted an efficient system which represented a sustainable approach to land (water) uses by adjusting to the burdens on the environment induced by various human activities. However, the system was drastically disrupted in the 20th century. In particular, during the processes of two radical changes in social systems, namely, socialization and the collapse of socialist system, the Kazakhstan-side of the Ili River basin underwent a transformation from nomadic pastoralism to sedentarized collective farming and semi-nomadic animal husbandry, and then a transition from centrally planned economy to market-oriented economy.

This article begins by introducing the study area. Section 3 explains the materials and analytical methods used for case study. Our alternative approach for sustainability assessment will be explained in the section too. Section 4 reports the analytical results from two aspects, i.e., changes in the hydrological cycle, agricultural development and consequent water uses. Section 5 concludes by discussing the analytical results using the alternative framework proposed in this study.

## 2. Study Area

The Ili River basin belongs to the Ili-Balkhash basin. Figure 1 presents the map of the Ili-Balkhash basin. The Ili-Balkhash basin is located across the Xinjiang Uygur Autonomous Region, China, and the Almaty Oblast, Kazakhstan. Geographically, the

Kazakhstan-side of the Ili-Balkhash basin is approximately the same size as the Almaty Oblast. It is worthy to mention that this article does not include the analysis results of the China-side of the Ili River Basin due to word limitation.



**Figure 1 Map of the Ili-Balkhash basin and the locations of observation sites**

Note: The graph legend of big view shows elevation derived from version 2 of the Shuttle Radar Topography Mission (SRTM) digital topographic data. Black dots indicate hydrological stations and gray square boxes indicate meteorological stations. 20551431001 and 20551542000 are the observation sites of GHCN Monthly, otherwise GHCN Daily.

The Ili River originates from the glacial melt water and precipitation of the northern Tianshan Mountains. It flows through the Kapchagai Reservoir, the Ili delta, and finally disappears into the terminal lake, namely, Lake Balkhash. The length of the

Ili River is about 1,400 km. The area of the drainage basin is about 413,000 km<sup>2</sup>. For the convenience of empirical analyses, we divide the Ili River basin into 4 parts according to the national border and major water facilities: the upper reaches (the China-side of the river basin), the middle reaches (from the border of China and Kazakhstan to the Kapchagai Reservoir, including the basins of the tributaries), the lower reaches (from the Kapchagai Reservoir to Lake Balkhash), and Lake Balkhash.

In the upper reaches of China and the middle reaches of Kazakhstan, there are dams wherein the water is diverted for irrigation. Especially, there are two large-scale reservoirs located in the Kazakhstan-side, namely, the Kapchagai reservoir and the Bartogai reservoir. The former was constructed for multiple purposes including power generation, irrigation and fishery in 1970. It is fed by the mainstream of the Ili River. The latter was constructed in 1983 and is fed by the tributary, Shelek river.

### **3. Materials and Methods**

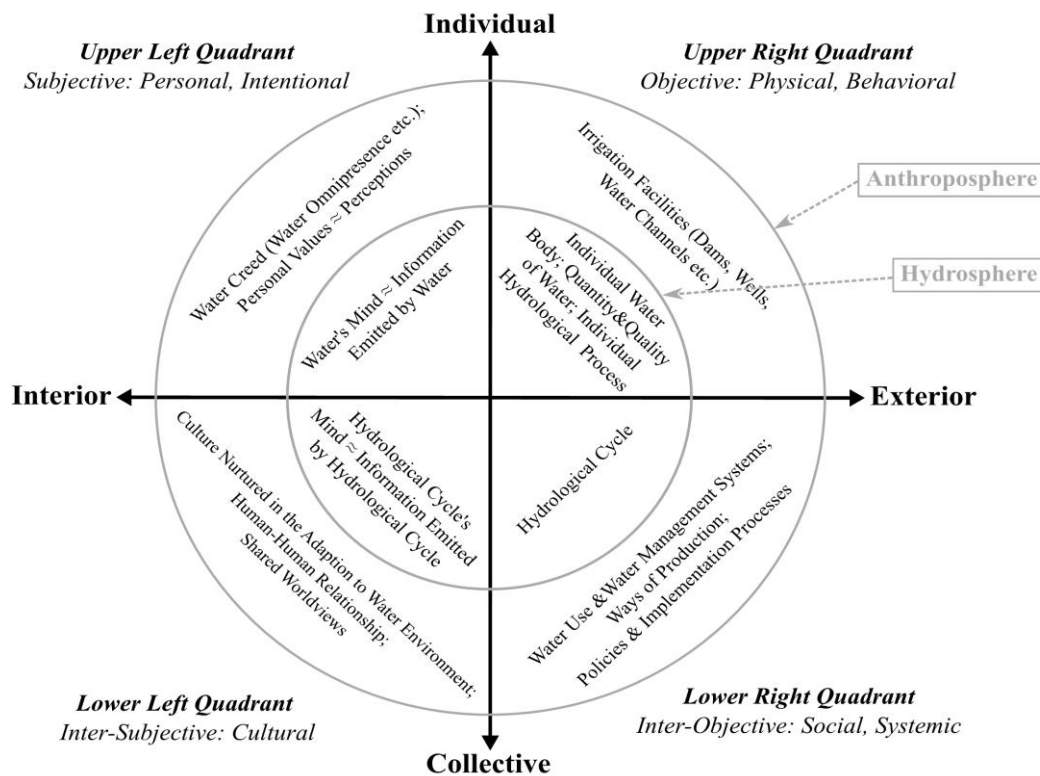
#### **3.1. Conceptual Framework: the Integral Approach**

The core of Wilber's integral approach is a four-quadrant framework that describes multiple aspects of reality. According to Wilber (2000; 2007), all phenomena in the world can be classified into four quadrants. These quadrants are four distinct dimensions of reality, or ways of viewing the same occurrence from four different perspectives. They are located in the interior and exterior of both individuals and collectives. The exterior aspects of objects are found on the right side, with physical and behavioral aspects in the upper right quadrant and social systemic aspects in the lower right quadrant. The interior aspects of objects are found on the left side, with intentional, personal, psychological aspects in the upper left quadrant and cultural aspects (collective values) in the lower left quadrant. Although the four quadrants are ontologically distinct, there is nevertheless an interwoven, intimate correspondence between them. Wilber (2000; 2007) argued that there needed to be a harmony among the quadrants if the whole system is to remain in balance. In addition, the origin of the quadrants also represents the origin of the development (evolution) process of each of four dimensions. The increases in one dimension could only be sustained with corresponding increases in the other dimensions.

Wilber's integral approach has been applied to a variety of fields. In the relevant fields of this study, it has been adopted by Hargens (2005), Hargens and Zimmerman (2009), Eddy (2005), Kayane *et al.* (2006), Kayane (2008), Voros (2001), and Floyd and Zubevich (2010). Among these, Kayane *et al.* (2006) and Kayane (2008) are the pioneering studies in applying the approach to water environment issues.

We further develop Kayane *et al.* (2006) and Kayane (2008)'s framework to differentiate anthroposphere and hydrosphere. Although more levels of complexity can be classified, we differentiate these two to focus on the relationships between human activities and water environment. The two spheres and four quadrants at each level develop eight niches in total. Figure 2 presents how our conceptual framework identifies different perspectives of the environmental problems in the Ili River basin, and shows the interactions among them. For example, regarding the lower right quadrant, changes in agricultural production would induce the construction of water facilities and

consequently result in changes of individual hydrological processes (upper right quadrant). In the meantime, government policies, programmes and practices to promote agricultural development (lower right quadrant) would influence the indigenous social constructs (lower left quadrant), while individuals' personal perception (views) about water (upper left quadrant) is formed based on the group-shared values and social constructs (lower left quadrant). Additionally, the individuals' personal perception (views), together with group-shared values, social constructs (lower left quadrant) would affect the individuals' behaviors toward environment (upper right quadrant).



**Figure 2 The 4-quadrant framework**

Note that Wilber's integral approach is philosophical instead of scientific. We modify it to conceptualize the various perspectives of sustainability, and all the empirical analyses in this study are conducted using traditional disciplinary methods. The changes in the lower right dimension are investigated using relevant statistics on land (water) uses including changes in irrigation area and amount of water intake. Social changes not to be captured by statistical data are depicted using interview results from fieldwork. The changes in the upper right dimension are investigated using long-term hydro-meteorological data such as precipitation and river discharge.

### 3.2. Data Description

#### 3.2.1. Land Use and Water Use Data

We collected statistics and hydrological data during fieldwork conducted in the Almaty Oblast, Kazakhstan, 2008. In particular, we collected land/water use statistics

including irrigation area (crop-specific), numbers of livestock and population (ethnic group-specific) from the Committee on Management of Archives and Documentation of Almaty area, Kazakhstan.

### 3.2.2. Hydro-meteorological Data

This study uses three types of hydro-meteorological data: precipitation, river discharge, and water level. Regarding precipitation, we use the datasets provided by the Climate Services Branch (CSB), National Climatic Data Center (NCDC) i.e., NCDC (2008a; 2008b; 2008c). Figure 1 indicates the locations of observation sites. After examining the validation of three datasets, GHCN Daily is extensively used in the study and GHCN Monthly as an additional source.

Regarding river discharge, we collected data from different observation sites of both mainstream and tributaries. In the case of mainstream, the discharge data at the Yamate, Kapchagai and Ushjarma stations are available for our study. In the case of the tributaries, the discharge data of the Talghar River, the Turgan River, the Esik River, the Shelek River and the Sharyn River are available. The discharge is measured at the locations where the rivers flow into the oasis cities; the locations wherein the impacts of human activities can be considered as negligible. The sum of the discharge of these five rivers is approximately equal to the total discharge of all tributaries. In addition, to examine the impacts of discharge control at the Bartgay reservoir of the Shelek River, we collected discharge data from both upstream and downstream stations of the reservoir.

Finally, regarding water level, we collect the data of lake level of Lake Balkhash and the water level of the Kapchagai reservoir to examine the impacts of discharge control at the Kapchagai reservoir.

### 3.2.3. Data Manipulation

#### Normalized Differential Integral Curve

This study applies the differential integral curve to investigate the long-term trends of precipitation and river discharge. As mentioned by Kezer and Matsuyama (2006), the curve is able to deduce the duration of the continuous low (high)-flow period in analyzing the long-term variations of river discharge. The computation of the curve consists of three steps: first, calculate the cumulative curves of the relative deviations of the annual mean discharge from its long-term mean; secondly, eliminate the variability of the time series from the curve. In this step, the years are classified based on the value of  $K_t$ . Specifically, a year is defined as a low-flow year if  $K_t > 75\%$ , while a year is defined as a high-flow year if  $K_t < 25\%$ . Finally, the normalized differential integral curve is defined as follows.

$$F(t) = \sum_{i=1}^n (K_i - 1) / C_v \quad (1)$$

$$K_t = Q_t / q \quad (2)$$

where  $F(t)$  is the normalized differential integral curve of  $K_t$  for year  $t$ ,  $Q_t$  is the annual

mean discharge for year  $t$ ,  $q$  is the average discharge over the whole study period, and  $C_v$  is the coefficient of variation of the annual mean discharge.

#### **Estimation of Water Consumption (Evapotranspiration)**

The crop evapotranspiration of irrigated area,  $ET$ , is computed by multiplying reference evapotranspiration by crop coefficient.

$$ET = K_c \cdot ET_0 \quad (3)$$

where  $ET$  denotes the crop evapotranspiration,  $ET_0$  denotes the reference evapotranspiration of irrigated area, and  $K_c$  denotes the crop coefficient.  $K_c$  is estimated by (Redakiiyey and Samkovoy, 2003) using the data of various crops (specifically, maize, sorghum, barley, alfalfa and tobacco) grown in the Almaty Oblast.

The reference evapotranspiration is estimated following the method proposed by Kondo and Xu (1997). Note that this study assumes the cloud cover is zero. The standard evapotranspiration is then estimated based on the heat balance at the surface using the daily mean air temperature, relative humidity and wind speed. The data for temperature is computed as the average of the daily maximum and minimum temperatures provided by GHCN Daily. Relative humidity is computed using the dew-point temperature. Since the observations of dew-point temperatures are limited, following Running and Coughlan (1988), this study assumes that the daily value of dew-point temperature is equal to the value of daily minimum temperature. The observations of the wind speed are limited as well. Therefore, after investigating the relationship between the daily mean wind speed and Day of Year (DOY) in the GSOD dataset, we computed the wind speed using the following function:

$$u = 0.12897 \cdot \sin(D/365 \times 2\pi) - 0.561681 \cdot \cos(D/365 \times 2\pi) + 2.87135 \quad (4)$$

where  $u$  is the daily average wind speed (m/s),  $D$  is the day of year. Root mean square error (RMSE) was 1.03 m/s over the 24-year period (7670 days).

## **4. Results**

### **4.1. Changes in Hydrological Cycle**

#### **4.1.1. Precipitation**

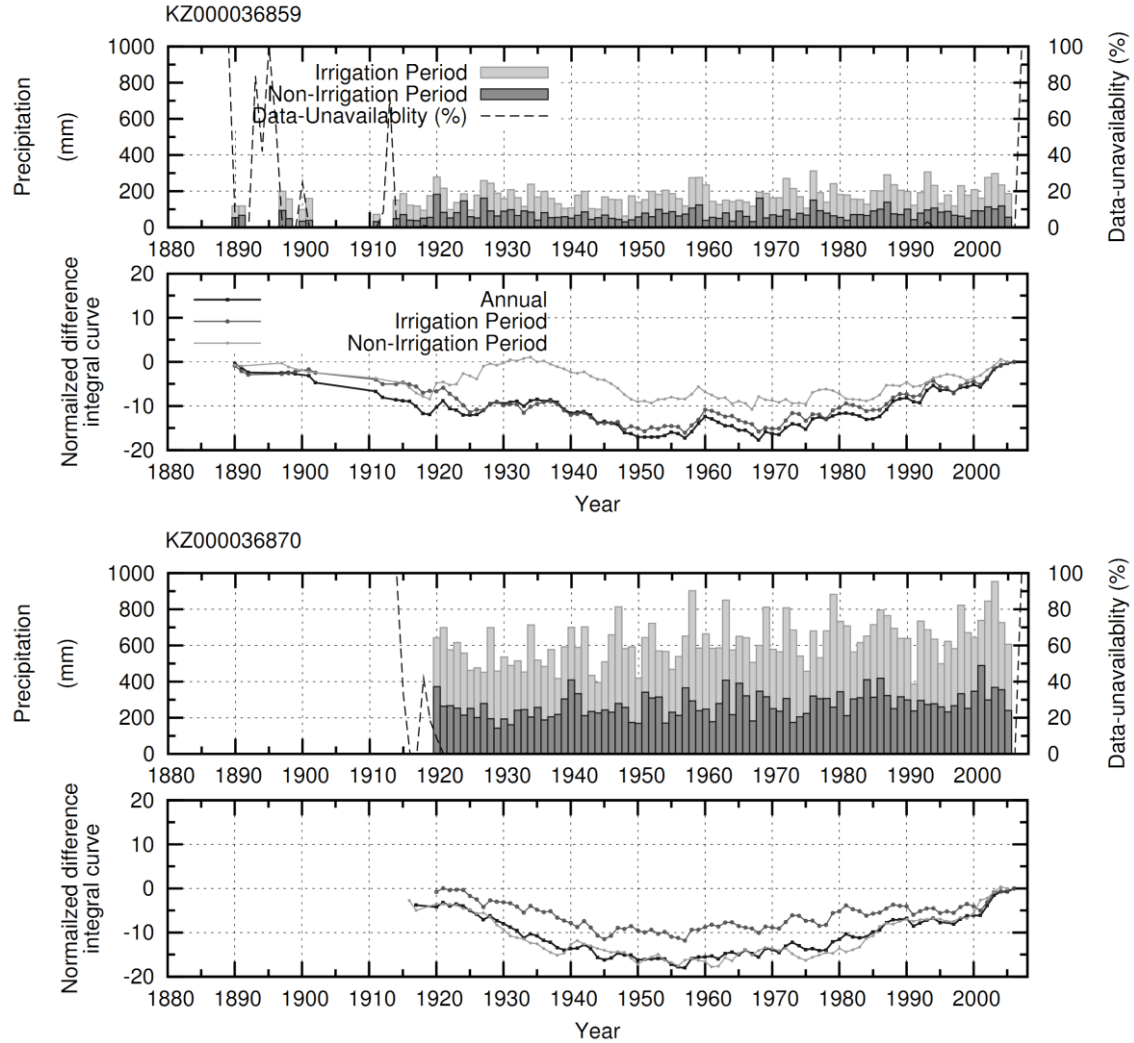
Figures 3 presents the changes in precipitation and the corresponding normalized differential integral curves at main observation sites of the GHCN dataset. With respect to the Kazakhstan-side, the data have been available since the 1890s. In the middle reaches, the trends of variations are similar at the two observation sites (KZ000036859 and KZ000036870). The precipitation had decreased during the late 1930s-1950s, and increased during the late 1960s-2006.

#### **4.1.2. River Discharge**

##### **Mainstream of the Ili River**

Figure 4 shows the changes in mainstream discharge at the hydrological stations Yamate and Kapchagai. The normalized differential integral curves show similar tendencies at both observation sites. Specifically, the annual discharge at Yamate showed an increasing trend during the period 1949-1973. It then turned to a decreasing

trend during the period 1974-1998, and moved back to an increasing trend after 1998. Meanwhile, the annual discharge at Kapchagai showed a slightly increasing trend during the period 1911-1942, and no substantial fluctuations during the period 1943-1958. During the period 1960-1998, it showed a significantly decreasing trend, which turned to an increasing trend after 1998.



**Figure 3 Changes in precipitation and normalized differential integral curves**

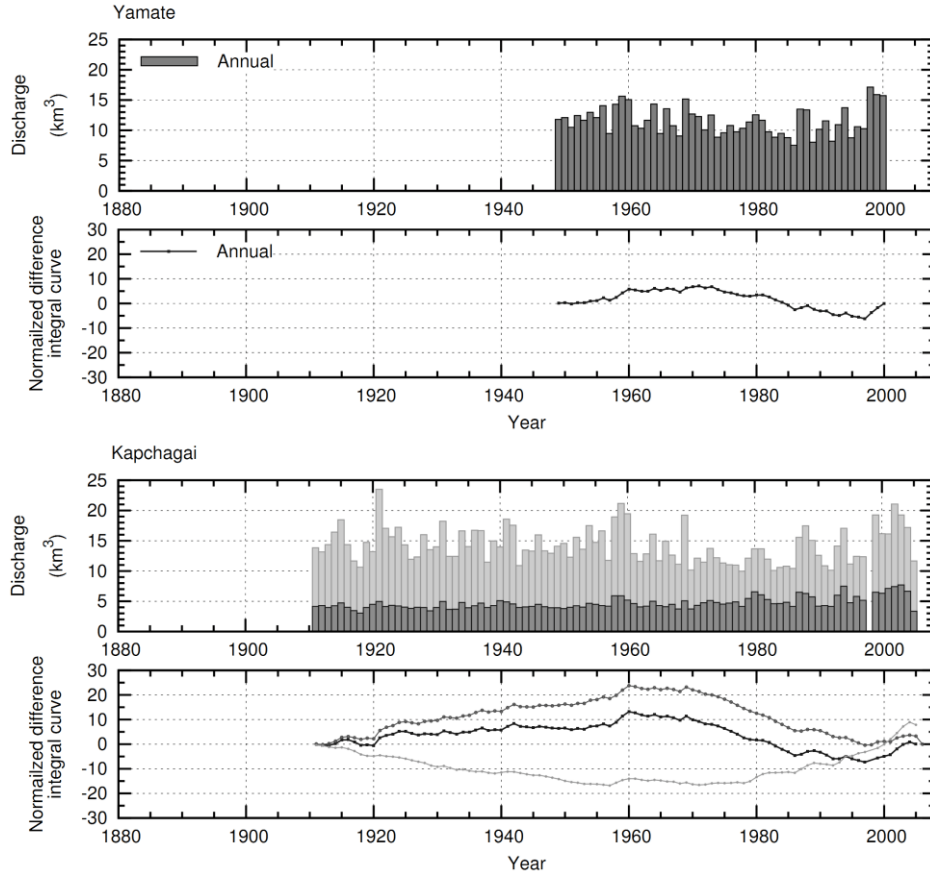
Equations (5) and (6) show the estimation results of the relationship between the annual discharge of Yamate and that of Kapchagai. The former shows the results of the period 1911-1969, i.e., the period before the construction of the Kapchagai dam, while the latter shows the results of the period 1970-2000, i.e., the period after the construction of the Kapchagai dam.

$$1911-1969: Q_K = 1.37 \cdot Q_Y - 1.87, \quad R^2 = 0.91 \quad (5)$$

$$1970-2000: Q_K = 0.85 \cdot Q_Y - 3.28, \quad R^2 = 0.64 \quad (6)$$



where  $Q_Y$  and  $Q_K$  are the annual river discharge at Yamate and Kapchagai.



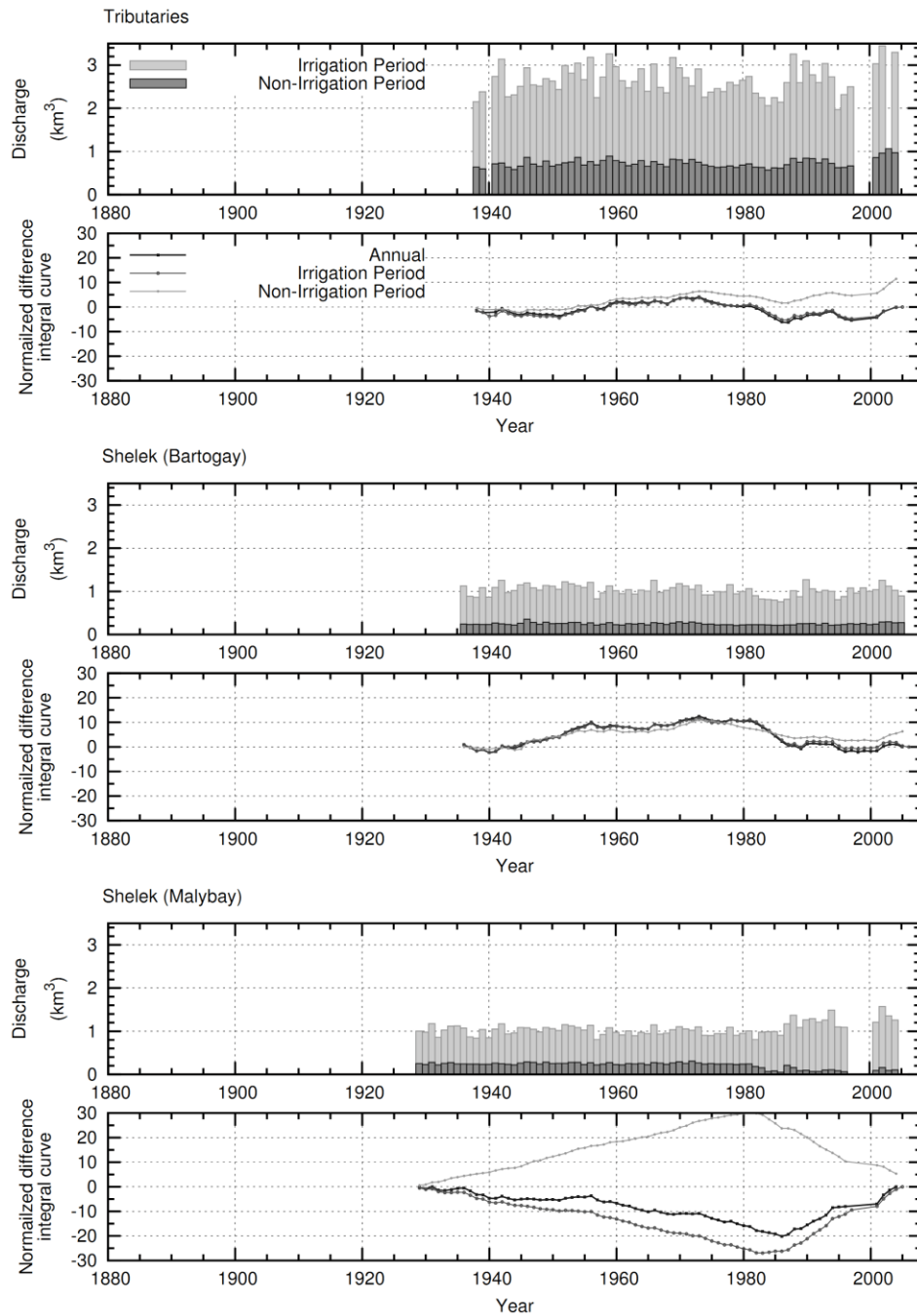
**Figure 4 Changes in river discharge and normalized differential integral curves of the mainstream (hydrological stations: Yamate, Kapchagai)**

The results from both estimations suggest a significantly positive correlation between the annual river discharge of Yamate and that of Kapchagai. Because the river discharge started to be controlled after the construction of the Kapchagai dam, the  $R^2$  of equation (6) is lower than that of equation (5). The mean of the annual release to the lower reaches had decreased from  $14.8\text{km}^3$  to  $11.6\text{km}^3$  after the dam was built. The decrease represents around 21% of the mean. In addition, the seasonal patterns of the river discharge at Kapchagai have changed substantially since the dam was built. The mean of the discharge during the non-irrigation period had increased from  $4.3\text{km}^3$  to  $5.4\text{km}^3$ , i.e. an increase by 25%. In contrast, the mean of the discharge during the irrigation period had decreased from  $10.5\text{km}^3$  to  $7.8\text{km}^3$ , i.e., a decrease by 25%. Accordingly, after the construction of the Kapchagai dam, the release during the non-irrigation period had increased, while the release during the irrigation period had decreased.

### **Tributaries of the Ili River**

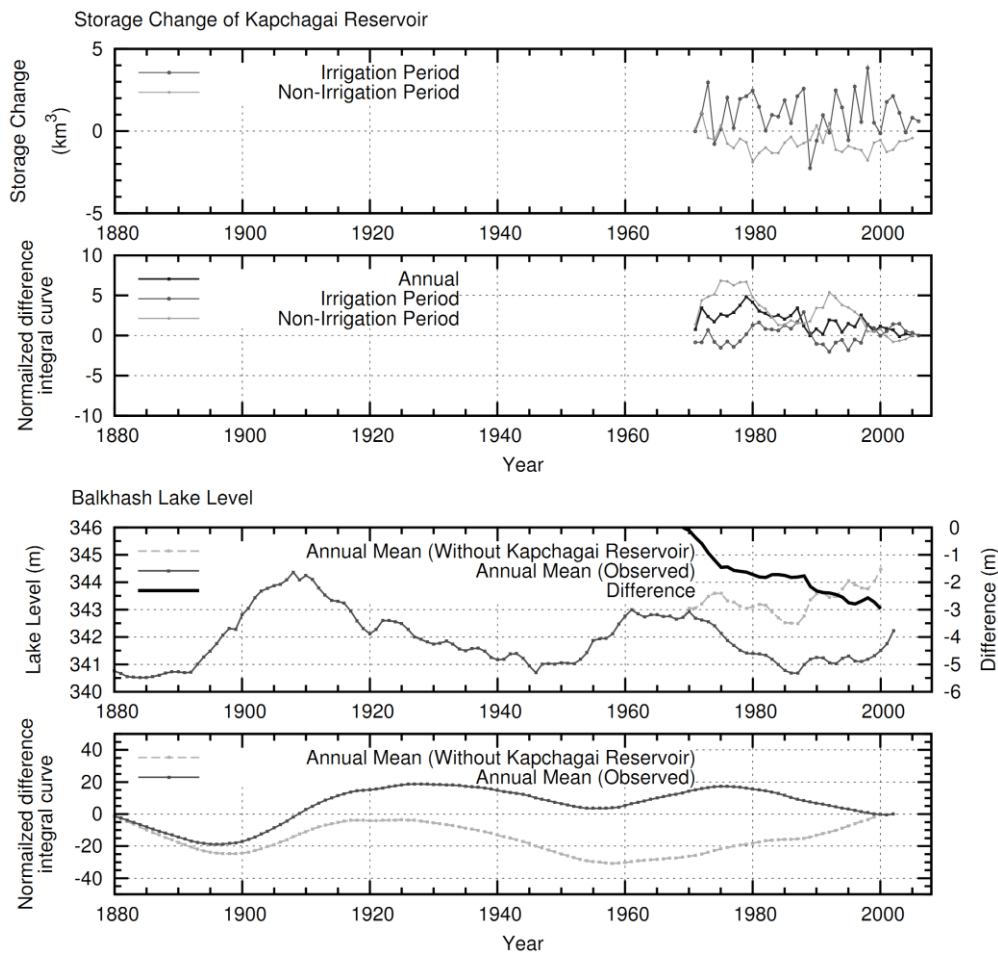
Figure 5 shows the river discharge and the corresponding normalized differential integral curves of the tributaries. The discharge of both upper reaches and the lower reaches are examined. The normalized differential integral curves of the

tributaries present completely different trends compared to those of the mainstream. For example, in the case of the upper reaches of the Shelek River (plot Bartogay in Fig. 5), the discharge shows an increasing trend during the period 1940-1956, a decreasing trend during the period 1982-1989, and no substantial fluctuations during the periods 1957-1981 and 1990-2006. In the lower reaches of the Shelek River (plot Malybay in Fig. 5), the discharge shows a decreasing trend during the period 1929-1986, and an increasing trend during the period 1987-2005.



**Figure 5 Changes in river discharge and corresponding normalized differential integral curves of tributaries**

In addition, the seasonal patterns of the river discharge at the lower reaches of the Shelek River (plot Malybay in Fig. 5) have changed substantially since the Bartogay dam was built in 1982. The mean of the river discharge during the irrigation period had increased from  $0.76\text{km}^3$  to  $1.1\text{km}^3$ , an increase of 1.5 times. In contrast, the mean of the river discharge during the non-irrigation period had decreased from  $0.25\text{km}^3$  to  $0.10\text{km}^3$ , a decrease by 60%. Accordingly, after the construction of the Bartogay dam, the release during irrigation period had increased, while the release during the non-irrigation period had decreased significantly.



**Figure 6 Changes in the storage of the Kapchagai reservoir and the water level of the Lake Balkhash**

#### **4.1.3. Storage Changes of Kapchagai Reservoir and Water Level Change of the Lake Balkhash**

The upper two plots of Figure 6 present the changes in the storage of the Kapchagai reservoir. It reaches maximum at the end of September, i.e., the end of the irrigation period. It reaches minimum at the end of March, i.e., the end of the non-irrigation period. Figure 6 clearly shows that the changes of the storage were positive during irrigation period, while minus during non-irrigation period in most of the years. In the case of the irrigation period, the mean of the difference of the annual

storage is  $+0.81\text{km}^3$ . In the case of the non-irrigation period, the mean of the difference of the annual storage is  $-0.61\text{km}^3$ . This implies that the water has been stored during the irrigation period, and released during the non-irrigation period.

The lower two plots of Figure 6 present the changes in water level of Lake Balkhash. The lake level had increased by 3.5m during the period 1886-1909. It had then decreased by 3.6m during the period 1910-1946, and increased by 1.7m during the period 1947-1969. After the construction of the Kapchagai dam, the lake level had decreased by 2.3m during the period 1970-1987, and then increased by 1.2m during the period 1988-2002.

## **4.2. Agricultural Development and Changes in Water Uses**

### **4.2.1. Pre-Soviet Era**

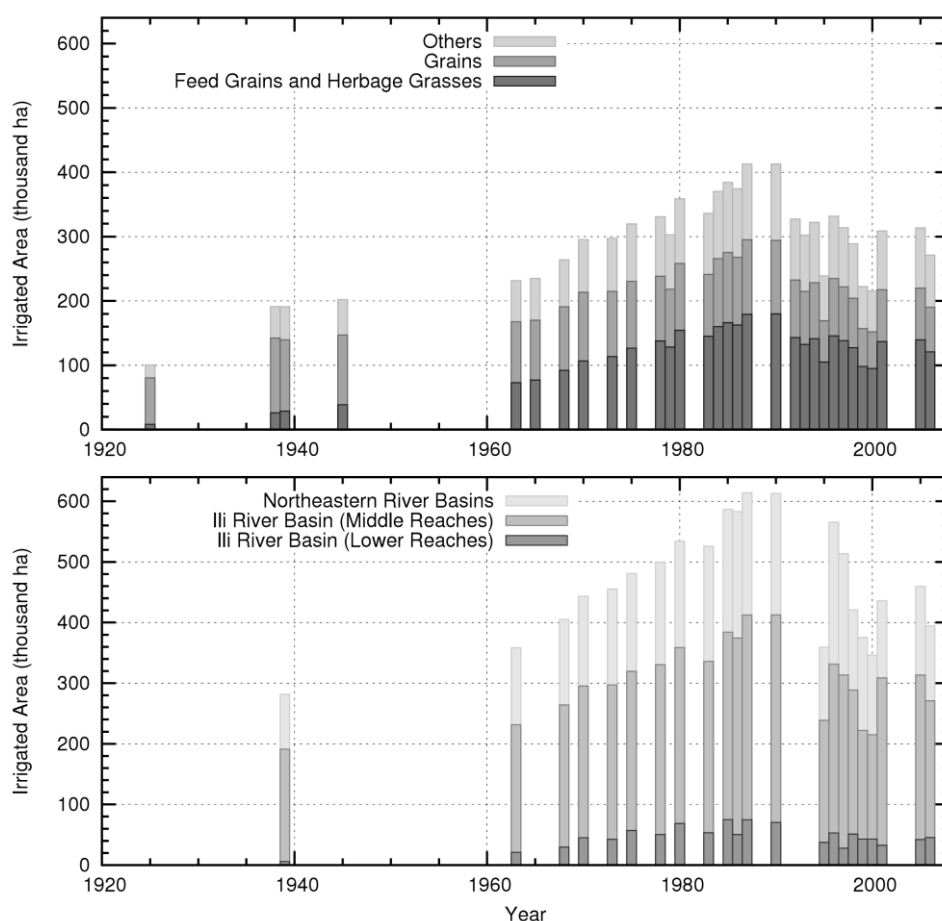
The Russians began advancing into the Kazakh steppe gradually since the 18th century. During the 19th century, most of the area of current Kazakhstan was under the domination of Russians. In 1889, a decree was promulgated to encourage the immigration of Russians to Kazakhstan. In the meantime, a large amount of land was nationalized in 1891. As a result, a grain-producing region was formed in northern Kazakhstan, while crop farming started to emerge in southern Kazakhstan including the Ili River basin wherein nomadic pastoralism used to dominate. The irrigated farmland of the Ili River basin and Balkhash basin amounted to 300.0 thousand ha and 437.0 thousand ha in 1900 (Redakiiyey and Samkovoy, 2003). Although the statistics are not available for the Ili River basin, according to Olcott (1995), by 1917 almost 75% of the population in Kazakhstan had some form of fixed winter quarters where grain was grown to feed livestock, and 50% migrated seasonally during May to September.

### **4.2.2. Soviet Era**

In 1917, the outbreak of the communist revolution had shaken the rule of the former Russian Empire. In 1920, an autonomous republic was established in the area of present-day Kazakhstan. It became one of the autonomous republics within the Russian Soviet Federative Socialist Republic (RSFSR). During the revolution period, agricultural production was tossed about by turmoil. Both cultivated areas and agricultural output dropped sharply. The irrigated area of the Ili River basin in 1925 (100.6 thousand ha) only accounted for one-third of that in 1900 (300.0 thousand ha) (Redakiiyey and Samkovoy, 2003).

After the end of civil war, the New Economic Policy (hereafter, NEP) was adopted to prevent the republic's economy from collapsing. Following the death of Lenin in 1924, Stalin gradually gained control of the Soviet Union. In 1925, he carried an aggressive industrialization strategy with the backing of the 14th Congress of the All-Russian Communist Party. Accordingly, Kazakhstan was placed as a supplier of raw materials to other constituent republics of the Soviet Union, and agricultural development was addressed to support industrialization. Afterwards, in December 1927, the 15th Congress of the All-Russian Communist Party decided to advance the collectivization of agriculture. As a major production base of grain crops, meat and wool for the Soviet Union, collectivization was particularly promoted to expand agricultural production in

Kazakhstan during the period of the First Five-Year Plan (1928-1932).

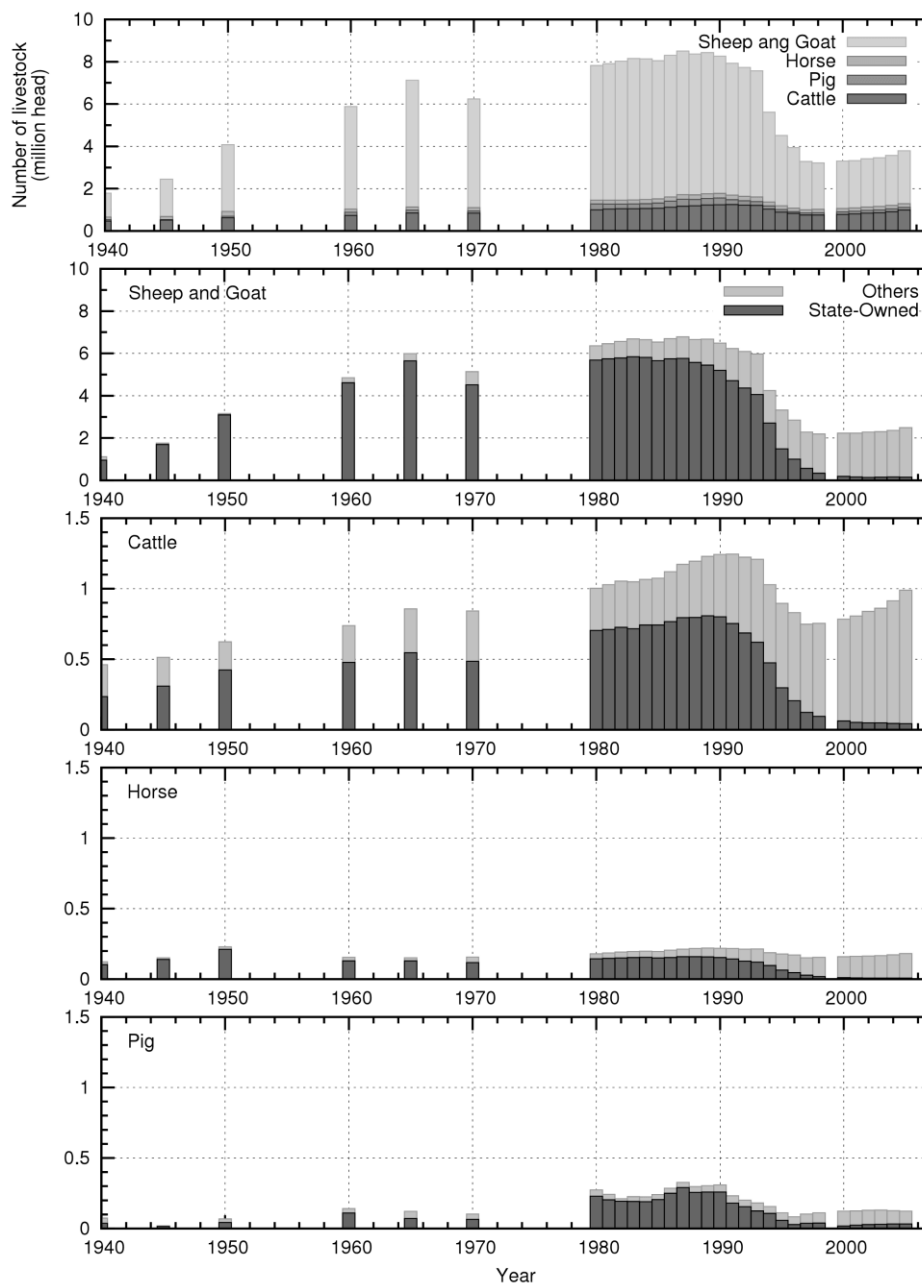


**Figure 7 Changes in irrigated areas.**

Note: The upper plot shows the crop-specific irrigated area of Almaty Oblast. The lower plot shows the region-specific irrigated area of the Ili River basin.

Kolkhozes (collective farms) and Sovkhozes (state-owned farms) were established. Nomads were assigned to farms and forced to sedentarize. By 1930, 28% of the Kazakhs' property was collectively owned (Poujol, 2006). By the end of 1932, the proportion increased to 54% in the semi-nomadic villages, and 35% in the nomadic villages (Poujol, 2006). In addition, collectively cultivated land accounted for 98% of the total, while collectively-owned livestock accounted for 88% of the total (Poujol, 2006). As a result of agricultural collectivization, stock-raising based on barns and the cultivation of fodder grain and fodder grass (hereinafter, forage) gained substantial development. Figure 7 shows that, compared to the 1920s, the irrigated area in the Ili River basin had increased by two times to 191.2 thousand ha in 1939. In addition, the cropping structure had shifted gradually from grain crops to forage, often under irrigation. In 1925, 72% of the total irrigated area was used for the cultivation of grain crops, while 8% was used for the cultivation of forage. By 1939, the percentage of grain crops declined to 58%, while the percentage of forage increased to 15%. Accordingly, the

numbers of livestock increased from 1.8 million in 1940 to 4.1 million in 1950 (Fig. 8).

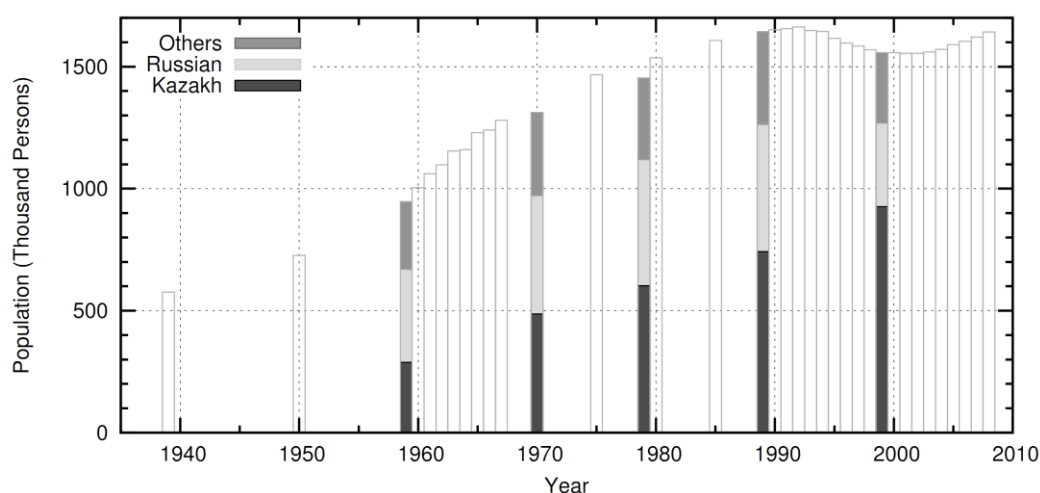


**Figure 8 Changes in numbers of livestock, Almaty Oblast**

Note: The top plot shows the changes in total numbers (livestock-specific).

The increasing trends of the irrigated area and the numbers of livestock further accelerated after Nikita Khrushchev initiated his ambitious “Virgin Lands” campaign in 1954. The campaign aimed to turn the pasture lands of Kazakhstan into a major grain-production base for the Soviet Union. In the six-year period after the initiation of the campaign, about 2 million people immigrated to Kazakhstan and 25 million ha of land were reclaimed. As a result, by 1962, the Kazakhs only accounted for 29% of the

total population. Figure 9 shows the changes in population (ethnic group-specific) of Almaty Oblast. The total population increased from 576.5 thousand in 1939 to 946.1 thousand in 1959. The numbers of migrants in 1960 accounted for two times that of Kazakhs. In particular, the number of Russian migrants amounted to 379.1 thousand, which was larger than that of Kazakhs by 91.2 thousand.



**Figure 9 Changes in population, Almaty Oblast**

Note: The transparent bars represent the changes in total population.

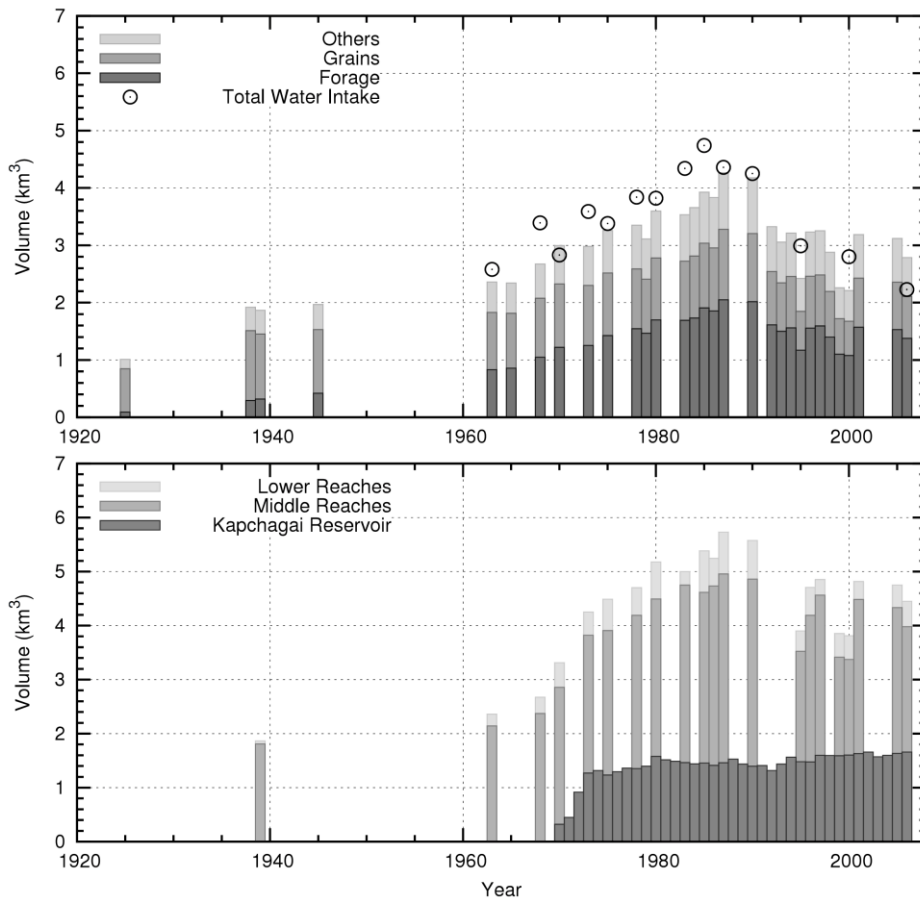
During the period of the “Virgin Lands” campaign, new Kolkhozes and Sovkhozes were established to accommodate the new migrants. In addition, Koreans were relocated to participate in the development of rice paddies. Accordingly, the irrigated area of the Ili River basin increased monotonically from 202.0 thousand ha to 412.6 thousand ha in 1987 (Fig. 7). Regarding the cropping structure, the proportion of forage maintained an increasing trend even after the construction of the Big Almaty Canal (Kunaev Canal). By 1990, the percentage of grain crops declined to 28%, while that of forage increased to 44% (Fig. 7). Largely due to the irrigation-based farming, the stock-raising industry in Almaty oblast had made remarkable progress. As shown in Figure 8, the number of livestock increased from 4.1 million in 1950 to 8.5 million to 1987. In the meantime, projects related to water resources development had been undertaken along the Ili River basin to provide irrigation water for the newly-reclaimed land. After the Kapchagai dam was established in the middle reaches of the Ili River in 1970, attempts have been made to grow forage using the desalinated and diluted water of the Lake Sorburak (salt lake), west of Almaty City since 1975. In 1982, the Big Almaty Canal and the Bartogay dam were established in the Shelek River basin. Accordingly, the water started to be diverted for irrigation in 1983. In the 1985 annual report, M. Portnyagin of the Almaty Bureau of Waterway Maintenance and Management stated that, “because there is no need to use local water resources for irrigation any more, the irrigated area can be expanded in the upstream of the Kunaev Canal”.

Figure 10 shows the changes in the annual water intake and the estimated results of crop-specific evapotranspiration. The relationship between the estimated

evapotranspiration and the total river water intake are shown as follows.

$$ET = 0.73 \cdot U + 0.55, \quad R^2 = 0.72 \quad (7)$$

where  $ET$  denotes the annual evapotranspiration, and  $U$  denotes the river water intake. Root mean square error (RMSE) was  $0.55\text{km}^3$  over the 14-year period. The estimated evapotranspiration presents similar trends as the changes of the irrigated area. The water consumption was low in 1920s due to the turmoil of the communist revolution ( $0.99\text{km}^3$  in 1924). It increased to around  $2\text{km}^3$  in 1940s attributable to the implementation of the sedentarization policy. Since the 1960s, it increased monotonically to reach the peak of  $4.2\text{km}^3$  in 1987.



**Figure 10 Changes in the evapotranspiration of the Ili River basin**

Note: The upper plot shows the changes in annual water intake and the crop-specific evapotranspiration estimated by crop coefficient method. The lower plot shows the evapotranspiration by sources.

#### 4.2.3. Post-Soviet Era

After the collapse of Soviet Union in 1991, Kazakhstan started its transition from centrally planned economy to market economy. Agricultural production fluctuated massively since then. It fell sharply, and then hovered at a low level in the 1990s. After 2000, production adjustment helped the agricultural sector recover to some extent but never reached the same levels as before the transition. The irrigated area and the number



of livestock had decreased sharply (Fig. 7 and 8). In the middle reaches of the Ili River basin, the irrigated area declined from 342.3 thousand ha (peak, 1987 and 1990) to 172.4 thousand ha in 2000. In the lower reaches of the Ili River basin, the irrigated area declined from 74.7 thousand ha (peak, 1987) to 28.0 thousand ha in 1997. The irrigated area of Almaty Oblast declined from 617.6 thousand ha (peak, 1992) to 346.3 thousand ha in 2000. The numbers of livestock in Almaty Oblast declined from 8.4 million (peak, 1989) to 3.2 million in 1998.

## **5. Discussion and Concluding Remarks**

### **5.1. Four-quadrants out of Balance: Induced by the Changes in Social Systems**

In the past, a balance between the water environment and human beings had been achieved in the Ili River basin through the ecosystem of nomadic pastoralism (Alimaev, 2003; Robinson and Milner-Gulland, 2003). However, during the Soviet era, large-scale agricultural development had been advanced by an authoritarian government in Kazakhstan. As a result, nomads were forcibly sedentarized, and their traditional social systems were abolished during collectivization. In addition, along with changes in agricultural production, the natural environment was heavily exploited. In the 4-quadrant framework, this implies that the protruding development (evolution) of the lower right dimension resulted in an imbalance in the whole system.

#### **5.1.1. Upper Right Quadrant: Changes in Hydrological Cycle and Degradation of Ecosystem**

The impacts of agricultural development significantly changed the hydrological cycle of the Ili River, and triggered the degradation of the ecosystem. In particular, the impacts in the case of Kazakhstan-side have been prolonged even after the collapse of the Soviet Union due to the existence of large-scale water facilities. The water resources development in the tributaries and mainstream of the Ili River has had caused severe degradation of ecosystems in the lower reaches.

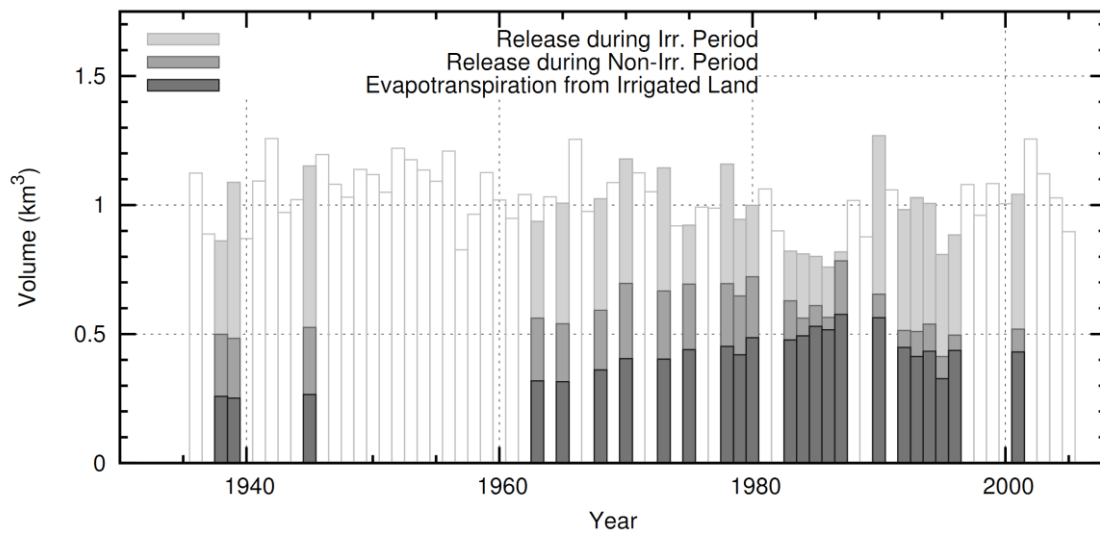
1. **Impacts of the Construction of Kunaev Canal and Bartogay Reservoir**

The Big Almaty Canal and Bartogay reservoir are the main water facilities in the Shelek River basin. The water intake for irrigation had increased gradually after the initiation of the “Virgin Lands” campaign. In particular, the water stored in the Bartogay dam during the non-irrigation period had been used for irrigation as well since 1982. Accordingly, the release to the downstream almost stopped during the non-irrigation period. After the collapse of the Soviet Union, water consumption decreased due to the shrinkage of irrigated areas. Consequently, the release during irrigation periods doubled that of 1980s; however, since the water had been continuously stored in the dam during non-irrigation periods, total release to the downstream had not changed much (Fig. 11).

2. **Impacts of Construction of the Kapchagai Reservoir**

Different from the Bartogay reservoir, river water had been stored during the irrigation period in the Kapchagai reservoir (Fig. 6) to ameliorate power shortages in winter. The release during the irrigation period had

decreased from  $10.5\text{km}^3$  to  $7.8\text{km}^3$ , i.e., 25% decrease from the level before dam construction. On the contrary, the release during the non-irrigation period had increased from  $4.3\text{km}^3$  to  $5.4\text{km}^3$ . In total, the release to the Ili delta and terminal lake had decreased by  $1.6\text{km}^3$  after the construction of the Kapchagai reservoir.



**Figure 11 Water Balance of the Shelek River Basin**

The decrease in release from the Kapchagai reservoir had spurred the decline of the water level of the terminal lake, i.e., Lake Balkhash. During the period 1970-1987, the water level of the Lake Balkhash declined from 342.9m to 340.7m. Note that the actual decline is more significant than 2.2m. In Figure 6, we estimated the lake water level excluding the impacts of the construction of the Kapchagai reservoir. The gap between the observed lake water level and the estimated lake water level had monotonically enlarged. During the period 1970-1974, the lake water level had declined by 0.5m due to the discharge control at the Kapchagai dam, although it was supposed to increase by 0.6m. Kipshakbaev and Abdrasilov (1994) and Abdrasilov and Tulebaeva (1994) argued that, during the period 1947-1974, groundwater storage in the delta reached its maximum. The groundwater level and the river water level were almost equal; the surface water-groundwater interaction was in equilibrium. There was little runoff loss of the river water in the Ili delta. Thus, it was the discharge control at the Kapchagai dam that prevented the rise of the lake level during the period 1970-1974. Afterwards, although the observed lake water level had increased to a certain extent since mid-1980s, the gap between the observed lake water level and the estimated lake water level maintained an enlarging trend.

#### **5.1.1. Upper Left Quadrant: Changes in Personal Values**

During the Soviet era, accompanied by the introduction of sedentarized stock-raising and the large-scale mechanized farming, individuals' view (perception) of nature has changed from a coexisting one to an exploiting one. This consequently

results in the changes in individuals' behaviors. This argument can be supported by the following evidence.

First, along with the penetration of irrigated farming, the Kazakhs' way of water use changed from traditional "green water" use to "blue water" use (Falkenmark and Rockstrom, 2004; Oki and Kanae, 2008). Before the implementation of the sedentarization policy, Kazakhs had rarely been engaged in farming. They grew forage and millet at winter camps when and only when they were unable to move seasonally due to the loss of livestock (Oikawa, 2004). In other words, the Kazakhs relied on precipitation for their lives. After agricultural collectivization, the stock-raising based on barns became popular. To support this non-mobile pattern of stock-raising, irrigated farming of forage had been promoted. In particular, after the initiation of "Virgin Lands" campaign, various irrigation facilities were constructed to make both the river water and groundwater accessible. As a result, the irrigated area for forage increased dramatically, and corresponding agricultural water consumption increased significantly.

Secondly, in the Soviet era, agricultural production was promoted regardless of geographical features and production costs. In order to fulfill production targets, new pastures were developed to support increasing numbers of livestock. In the remote area of sand dunes, since the snow cover could provide drinking water for livestock, traditionally, only the northern slope was used for pastures in the winter camps while the southern left undeveloped. During the period of the "Virgin Lands" campaign, deep wells were sunk in the southern slope, and water was extracted by pumps where the water table was deeper, or even brought to summer camps by trucks in some instances. Consequently, both slopes of dunes were turned into permanent pastures. In the case of dairy farmers near the cities, production relied on local water supply; however, the hay to feed the livestock was presumably mobilized from the places outside of the river basin.

Thirdly, after the construction of various water facilities, especially the establishment of dams, the seasonality of the hydrological cycle was ignored in the decision process of water storage/release. Water resources have been exploited in an unsustainable way. As mentioned in section 5.1.1, at the Bartogay reservoir, water is stored in winter, and released in summer for irrigation. In contrast, at the Kapchagai reservoir, water is stored in summer, and released in winter for power generation. Although the purposes for constructing the two dams are different, in both cases, the natural hydrological cycles have been altered and controlled at humans' discretion.

### **5.1.3. Lower Left Dimension: People's Suffering and Lost Culture**

The forcible and sudden shift from nomadic pastoralism to settled farming and semi-nomadic animal husbandry in the form of political campaigns resulted in the suffering of local people. In addition, Kazakhs' traditional culture formed and closely associated with nomadic pastoralism largely disappeared during the Soviet era.

First, the introduction of agricultural collectivization destroyed the existed social structure of the Kazakhs because mobility played an essential role in building their traditional communities. Traditionally, Kazakhs practiced long-distance migrations to reduce the risks of natural disasters. The major migration routes were partitioned

between tribes which were often formed on the basis of kinship. Russia's invasion and socialist revolution dismantled tribal communities, consequently changing the migration routes and hurting the bonds of kinship. In the 1920s, two rounds of land reform were carried out in Kazakhstan. In the case of the first round of land reform, traditional feudalism systems were abolished, and livestock was collected from the so-called big feudal owners, feudal lords and Kulaks. In the case of the second round of land reform, a radical campaign (decree of August 27th, 1928) was implemented to confiscate property from the people recognized by the authority as feudal or semi-feudal. According to Poujol (2006), during the second round of land reform, 145.0 thousand heads of livestock were confiscated from 657 large-scale owners. During the process of collectivization, people were reorganized in the form of Kolkhozes and Sovkhozes. By the end of the Soviet period, household-based pastoralism and indigenous community organizations had been replaced in the countryside by big mechanized farms staffed by agricultural workers.

Secondly, radical political campaigns to promote agricultural collectivization led to disastrous social consequences during the Soviet era. Widespread famine was caused by the turmoil of agricultural production. In the meantime, people who were against government policies suffered from intensified political oppression. After land reforms and collectivization were implemented, agricultural production fell into chaos. Nomads slaughtered their herds because they were unwilling to hand over their livestock to Kolkhozes and Sovkhozes. In 1929, there were 39.1 million heads of livestock in Kazakhstan. This number decreased to 4.4 million on January 1st, 1933 (Poujol, 2006). The dramatic decline in agricultural output entailed sustained famine in the 1920s. In addition, during the ruling period of Stalin, farmers who were against sedentarization and collectivization policies were deemed enemies of people, and the intellectuals and social/political activities almost completely disappeared in Kazakhstan. In 1930, 1.7 million of Kazakh population died of Stalin's political repressions, and about one-third (2,100 thousand) of the total population (6,420 thousand) lost their lives (Poujol, 2006).

#### **5.1.4. Lower Right Quadrant: Changes in Social Constructs**

Similar to the prolonged impacts on natural landscape, the impacts on human-human relationships were prolonged as well. The impacts of collectivization on Kazakh society were profound that, even after the break-up of the Soviet Union, indigenous communities were often not able to be restored.

After the break-up of the Soviet Union, although the viability of the Kolkhozes and Sovkhozes was undermined, the length and severity of collectivization hindered the revival of indigenous communities in filling in the organizational void (Behnke, 2003). Instead, stratification emerged among Kazakh pastoralists. A group of richer farmers invested steadily by increasing their stock numbers, buying equipment, occupying good pasture land, improving production methods and marketing on a commercial basis (Kerven, 2003). Meanwhile, the majority of farmers remain subsistence-oriented, as they own insufficient number of animals to accumulate wealth through marketing or investing in livestock production (Kerven, 2003).

The irrigation facilities, farmland, and pastures developed during the Soviet era were largely abandoned after the economic transition. Before 1991, the irrigation facilities including water channels, used to be managed by the Kolkhozes and Sovkhozes. After the collapse of the Soviet Union, due to the vagueness of property rights, many of those facilities were left without proper management, and eventually turned into ruins. Regarding the farmland and pastures, many of them were reclaimed ignoring geographical features and production costs. They are not sustainable under the normal conditions of a market economy. Before 1991, agricultural produce made in newly-reclaimed farmland would be brought to the other republics of former Soviet Union. The machinery, water, and forage would be brought to pastures by trucks regardless of the distance. After 1991, long-distance transportation became costly due to price hikes in fossil fuels. In addition, the export of the agricultural produce became difficult after the constituent republics of the former Soviet Union declared independence. Accordingly, costly production can no longer be continued.

## **5.2. Concluding Remarks**

After the collapse of the Soviet Union, environmental degradation in Central Asia, as represented by the Aral Sea crisis, attracted much attention of academia. The management of water, the region's scarcest and shared resource, as politic, as social, as economic as it is environmental. In the literature, one line of studies considered the Soviet political system and the pursuit of rigid command-style economic planning as the fundamental cause of the environmental degradation in Central Asia. In the meantime, another line of studies argued that the introduction large-scale irrigation techniques and collective farming are the fundamental causes of the environmental disasters in Central Asia. In this study, by using Kazakhstan as a case study, we illustrated that both probably captured part of the truth because all above-mentioned reasons and result of environmental degradation are coherent perspectives of sustainability problem in the study area. The reality is more complex, and various perspectives are presumably interlocking with each other.

Not unique to the Kazakhstan case or Central Asia, the traditional disciplinary approaches are not effective enough to provide a heuristic for identifying and understanding the current global environmental problems of complexity. That's why in this study we made the efforts to apply AQAL, a framework of futuristic studies, in environmental studies. In particular, though empirical oriented, we attempted at coordinating the analytical results in a coherent way following conceptual 4-quadrant framework. We found that the protruding development of the lower right quadrant in the form of agricultural development, sedentarization, collectivization etc. is the fundamental cause of environmental degradation in the Ili River basin. In addition, the protruding changes in social systems not only resulted in the environmental degradation, but also drastically changed the perception, culture, and behaviors of the local community. All these issues are interwoven deeply with each other.

Although our 4-quadrant framework is still under development, the findings from the case study imply the possibility to apply it to sustainability assessment. The current two broad forms of sustainability assessment (EIA and SEA) basically start from

trade-offs between various perspectives of sustainability through evaluating environmental impacts of plans, projects, and programmes (ex-ante or ex-post). In contrast, our approach highlighted the inter-relatedness/inter-connection of those perspectives. The approach appears to be effective in coordinating/transcending the interpretations from different disciplines. By examining the historical changes in water management of the Ili River basin, presumably but not exhaustively, we presented that the promulgation and actual practices of development strategy need consider the interlocking relationships of social systems, natural environment, personal values and cultures. The 4-quadrant framework proposed in the study is such an attempt to conceptualize and reify the integrative/holistic view of sustainability.

## References

- Alimaev I. I. 2003. Transhumant Ecosystems: Fluctuations in Seasonal Pasture Productivity. In *Prospects for Pastoralism in Kazakhstan and Turkmenistan*, Kerven C., Eds. 31-51, Routledge, London and New York.
- Behnke, R. H. 2003. Reconfiguring property rights and land use. In *Prospects for Pastoralism in Kazakhstan and Turkmenistan*, Kerven C., Eds. 75-107, Routledge, London and New York.
- Eddy, B. G. 2005. Integral geography: space, place, and perspective. *World Futures* 61: 151–163.
- Hargens, S. E. 2005. Integral ecology: The what, who, and how of environmental phenomena. *World Futures* 61: 5–49.
- Hargens, S. E., and Zimmerman, M. E. 2009. *Integral ecology: uniting multiple perspectives on the natural world*. Shambhala Publications Inc., Boston, Massachusetts.
- Falkenmark, M., and Rockstrom, J. 2004. *Balancing Water for Humans and Nature*. Earthscan, London.
- Floyd, J., and Zubevich, K. 2010. Linking foresight and sustainability: An integral approach. *Futures* 42: 59–68.
- Kayane, I. 2008. Environmental problems in modern china: Issues and outlook. In *New Challenges and Perspectives of Modern Chinese Studies*, Kawai, S., Eds. 265–285, Universal Academy Press Inc.
- Kayane, I., Miyazawa, T., and Zhu, A. 2006. Water and society in the old town of Ilijiang. *Water Science* 291: 41–72. In Japanese.
- Kerven, C. 2003. Privatization of livestock marketing and emerging socio-economic differentiation. In *Prospects for Pastoralism in Kazakhstan and Turkmenistan*, Kerven, C., Eds. 146–165, Routledge, London and New York.
- Kezer, K., and Matsuyama, H. 2006. Decrease of River Runoff in the Lake Balkhash Basin in Central Asia. *Hydrological Processes* 20: 1407–1423.
- Kipshakbaev, N. K., and Abdrasilov, S. A. 1994. Effect of economic activity on the hydrologic regime and dynamics of the Ili delta. *Hydrotechnical Construction* 28, 416–420.
- Kondo, J., and Xu, J. 1997. Potential evaporation and climatological wetness index. *Tenki* 44: 875–883. In Japanese.

- NCDC. 2008a. Global Surface Summary of the Day (GSOD) Version 7. NCDC, available on line at <http://www7.ncdc.noaa.gov/CDO/cdoselect.cmd?datasetabbv=GSOD&countryabbv=&georegionabbv=>.
- NCDC. 2008b. Global Historical Climatology Network (GHCN Daily) Version 2. NCDC, available on line at <http://www.ncdc.noaa.gov/oa/climate/ghcn-daily/>.
- NCDC. 2008c. Global Historical Climatology Network (GHCN Monthly) Version 2. NCDC, available on line at <http://www.ncdc.noaa.gov/oa/climate/ghcn-monthly/index.php>.
- Nobe, K. 2003. *CIS nougyo josetsu: kysoren niokeru taiseiikouka no nougyou*. Policy Research Institute, Ministry of Agriculture, Forestry and Fisheries. In Japanese.
- Oikawa, T. 2004. Soviet renpouki niokeru Kazakhstan no kachikushiiku no jirei kara. *Eurasia Gengo Bunka Ronsyu, Chiba University* 7: 13–23. In Japanese.
- Oki, T., and Kanae, S. 2008. Global hydrological cycles and world water resources. *Science* 313: 1068–1072.
- Olcott, M. 1995. *The Kazakhs*. Hoover Institution Press, Stanford, CA.
- Pope, J., Annandale, D., and Morrison-Saunders, A. 2004. Conceptualizing sustainability assessment. *Environmental Impact Assessment Review* 24, 595–616.
- Poujol, K. 2006. *Kazakhstan*. , translated by Uyama, T., and Suda, M. Hakusuisha. In Japanese.
- Redakiiyey, P., and Samkovoy, A. B., 2003. *Problemy gidroekolgicheskoy ustoychivosti v bassejne ozera Balkhash*. Kazgydromet, Almaty. In Russian.
- Robinson S., and Milner-Gulland E. J. 2003. Contraction in livestock mobility resulting from state farm reorganization. In *Prospects for Pastoralism in Kazakstan and Turkmenistan*, Kerven C., Eds., 128–145, Routledge, London and New York.
- Running, S.W., and Coughlan, J. C. 1988. A general model of forest ecosystem processes for regional applications: I. Hydrologic balance, canopy gas exchange and primary production processes. *Ecological Modeling* 42: 125–154.
- Voros, J. 2001. Reframing environmental scanning: An integral approach. *Journal of futures studies* 3: 533–551.
- Wilber, K. 2000. *A Theory of Everything: An Integral Vision for Business, Politics, Science and Spirituality*. Shambhala Publications Inc., Boston, Massachusetts.
- Wilber, K. 2007. *Integral Spirituality: A Startling New Role for Religion in the Modern and Postmodern World*. Shambhala Publications Inc., Boston, Massachusetts.

# The conditions for strong sustainability

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Track 2a: Assessing and reporting limits in natural and human systems

Oral

## Abstract

Weak sustainability and strong sustainability imply different aggregation functions that involve different assumptions of substitutability between factors. Weighting is always normative. It may be explicit or may consist of the selection of a single unit or dimension. I redefine weak sustainability as the reduction of complexity to a single dimension. There are therefore as many weak sustainability indicators as possible choices for this single dimension. Strong sustainability is characterized by the multiplicity of dimensions or critical capitals which, if any are exceeded, suffice to determine the non-sustainability. It appears that it is possible to identify in any calculation of a sustainable development indicator, a relatively objective component of sustainability and a negotiable component of shared rights and responsibilities. This has practical utility for assessing the choice of metrics and clarifying the negotiation issues.

**Keywords:** strong sustainability, critical capital, aggregation, indicator, negotiation, responsibility, distribution, equity

## 1. Introduction

Strong and weak sustainability have been widely discussed and have lead to a quantity of indicators [Daly, 1997a, Zaccai, 2002, Neumayer, 2003, Pearce et Barbier, 2000, Daly, 1997b, Stiglitz, 1997, Solow, 1997]. Following the weak (or neoclassical) perspective, sustainability is determined by the conservation of utility or consumption level, which is a function of the production ultimately determined by the total capital including economic, social and natural capitals [Solow, 1974, Solow, 1993]. Sustainability is a question of maximising total utility (or consumption) on an infinite time [Martinet et Rotillon, 2007, Heal, 1998].

Consider a set  $KS$  of *substitutable* capitals  $k_j$ ,



$$KS = \{k_1, k_2, \dots, k_n\}$$

Let  $k$  be the sum of substitutable capitals

$$(1) k = \sum_{i=1}^n k_i$$

and let  $k'$  be the growth of total capital

$$k' = k_t - k_0$$

The generalized condition of weak sustainability is [Kestemont, 2010]:

$$(2) k' \geq 0 \quad \text{Total capital should not decrease}$$

Note that it is the total capital per capita that should not decrease [UNECE, 2009]. The fair distribution of this total capital (or at least of the related utility) can further be discussed. One can fix an individual poverty line [Blackorby et Donaldson, 1982] or only consider the global situation [Solow, 1974]. In the latest case, the individual threshold is implicitly equal to zero, the distributional problem being considered a normative or ethical (not scientific) question.

Expressed in monetary unit per capita, a typical example of weak sustainability indicator is the genuine savings (or adjusted net savings ANS) [World Bank, 2006]. The uncertainties and ethical positions relative to the monetary indicators including GDP are largely commented [Gowdy, 2005, Abdallah, Thompson et Marks, 2008, Diener, 1984, Veenhoven, 1991, Easterlin, 1995, Mentzakis et Moro, 2008, Stevenson et Wolfers, 2008, van den Bergh, 2007, Fleurbaey, 2008].

The choice of the single monetary unit is not so simple in practice in a real "imperfect" market. One has to choose a reference currency, a base year for prices, a weighting scheme for purchasing power parities etc. Perfect substitutability does not imply using a monetary unit to express economic capitals or flows. Other units like energy (or exergy) content or tons of materials could be preferred (haberl, Kestemont). Biosphere protectors prefer to use the global hectares of biocapacity and the related ecological footprint. All these initiatives pertain to the weak sustainability metrics. Actually, there are as many "sustainability" indicators as authors and points of views. The choice of the unit and/or the weights is always a normative choice that can be easily criticized. Another problem in the "total capital" approach is that unknown capitals are implicitly weighted zero. New "discoveries" of previously neglected of unknown capitals (like natural capitals) and their internalization would lead to an erroneous impression of sustainability (apparent total capital growth).

Let  $w_j$  be non-negative weights of perfectly substitutable capitals

$$W = \{w_1, w_2, \dots, w_n\},$$

$$\sum_{j=1}^n w_j = 1, w_j \geq 0 \text{ pour } j = 1, \dots, n.$$

The weighted arithmetic mean of capitals,  $A(k)$ , is :

$$(1') \quad \bar{k} = A(k) = \sum_{j=1}^n w_j k_j$$

Let the growth of mean capital be

$$\bar{k}' = A(k_t) - A(k_0), (t = \text{at time } t, 0 = \text{at initial time})$$

The condition for weak sustainability (2) becomes

$$(2') \quad \bar{k}' \geq 0 \quad \text{The mean capital should not decrease.}$$

A policy of weak sustainable development is to maximize the average capital

$$(3) \quad \max \bar{k}'$$

For strong sustainability, there is a natural limit whether in the form of the irreversibility of certain natural changes (laws of thermodynamics) or in absolute scarcity [Daly, 1977, Barbier, 1989, Barnett et Morse, 1963, Underwood et King, 1989, Baumgärtner et al., 2006, Georgescu-Roegen, 1971]. Species extinctions and radioactive contamination are example of irreversible phenomena. These limits can be simple (direct), as in the case of the exhaustion of a gas tank or complex (combined) when multiple sources and products come into play, as for the control of a fire or survival of a species. These limits may be absolute or relative to space (density, concentration), time, speed (change), the container (specific resistance). For example, the toxicity of this substance to the nature or the human being determines local limits.

In this paper, I propose three principles as a framework for selecting sustainability indicators: strong sustainability, responsibility and equity.

## **2. Sustainability: critical capitals**

### **2.1. Conditions for strong sustainability**

Consider a set KR of critical capital  $k_r$  (not substitutable and non-zero):

$$KR = \{k_1, k_2, \dots, k_n\}$$

Let  $k_r'$  be the growth of each critical capital:

$$k_r' = k_{rt} - k_{r0}$$

$k_{r0}$  = capital  $r$  at initial time

$k_{rt}$  = capital  $r$  at  $t$  time

The generalized condition of sustainability is [Kestemont, 2010]:

$$(4) \quad \forall k_r \in KR, k_r' \geq 0$$

*Any critical capital must maintain or increase*

Any critical capital suffices to determine unsustainability. It is not necessary to find a weighting method (or a single unit) to determine unsustainability: each problem must be assessed with a relevant unit. Examples of global critical capitals or factors are climate change, ocean acidification, stratospheric ozone, the biogeochemical cycles of nitrogen and phosphorus, the overall use of fresh water, change of land use, biodiversity, fish stock, toxic concentrations, biocapacity, access to food, health and minimum life conditions, copper, nickel, lead, tin, energy return on energy investment [Rockström, 2009, Gately, 2007, Cleveland et al., 1984, Kesler, 1994, Wackernagel et Rees, 1996, Daly, 1973]. Stocks of minerals and fossil fuels should be stabilized as soon as possible since only a natural resource being both renewable and substitutable can be consumed in a sustainable manner [Hartwick, 1977, Hotelling, 1931, Martinet et Rotillon, 2007, Comolli, 2006]. Other critical capitals result from the combination of different phenomena, such as eutrophication which depends on the fixing of phosphorus and nitrogen from the atmosphere by industry and agriculture [Carpenter et al., 1998]. The various expressions of "weak total capital"  $k$ , of formula (1), like genuine savings or biocapacity have all the characteristics of critical capitals among others, which should also be maintained.

It appears that strong sustainability as defined here is a more general model than the weak sustainability since it allows to include conditions of weak sustainability, not vice versa.

An uncertainty remains about the determination of eligible "limits" of these critical assets. Low and high assumptions are usually necessary and involve a normative choice of risk that humanity is ready to run, in which an ethical factor may intervene [Rockström, 2009]. Therefore, even if science determines critical factors and probable limits, we say that the limits are *relatively objective*. Their distribution between actors and local targets or quotas is of course normative.

## 2.2. Mathematics for strong sustainability

Weighted or not weighted sums, products or ratios and related means mathematically imply possible substitution between the factors.

The arithmetic function has no unambiguous meaning for unmatched variables, such as temperatures expressed in different units, or temperatures and masses [see Ebert et Welsch, 2004]. This is enough to disqualify most of the sustainable development synthetic indices of

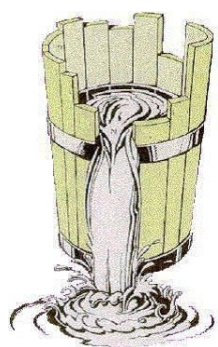
the literature, most of them using an arithmetic aggregation of incomparable phenomena [Singh et al., 2009]. How could we then "scientifically" aggregate incomparable factors? The only way to aggregate non comparable interval scales is a "dictatorial" ranking on one arbitrary variable, ignoring the other variables<sup>1</sup>.

Let us propose the following aggregation function:

$$(5) \quad \min (k_r') \geq 0 \Rightarrow \text{sustainable}$$

*Unsustainability is determined by the most threatened critical capital*

Formula (5) reflects unsustainability whatever the unit or weighting method used. It is sufficient that the result is less than zero to determine that there is unsustainability.



**Figure 1 :** The most critical capital limits the maximum capacity

Figure 1 illustrates the concept of "aggregated" capital according to the strong sustainability. If each plank is a critical capital, or a non-substitutable production factor ("limiting factor"), it is the shortest plank that determines the capacity of the bucket.

A sustainable development policy would "simply" consist of maximising the most critical factor<sup>2</sup>.

$$(6) \quad \max (\min (k_r'))$$

This principle provides a criterion for selecting the most relevant parameters for benchmarking or sustainability performances: other factors (the longest planks in figure 1) are simply not important and can be neglected unless they attain a "critical" limit at the studied scale (world or local).

Formula (5) only identifies the most critical factor in case of unsustainability. Nuances such as "more or less sustainable" or "degrees of sustainability" are necessarily normative [Kestemont, 2010]. It depends on the weights one might attribute to different non-substitutable critical factors (for example to choose between unsustainable biodiversity evolution and unsustainable environmental health for the people).

<sup>1</sup> Following the Arrow's theorem according to which it is impossible to develop an (not dictatorial) aggregate preference from ordinal individual preferences [Arrow, 1951].

<sup>2</sup> For a discussion on the maximin, see Arrow [Arrow, 1978]. For an application to individual critical capitals of "capabilities", see Sen [Sen, 1977].

For non comparable variables in scale ratio, ratios or geometric means are possible under certain conditions (positive values, non-negative weights)[Tsui et Weymark, 1997, Ebert et Welsch, 2004]. "Distances to target" types of indicators can have these properties, as well as "head counts" types of indicators like percentage of poor people, percentage of indicators exceeding a reference value for a given country, percentage of threatened species, etc.

Ratios are equivalent to a normative weighting scheme. For example, decoupling indicators or efficiency indicators of the type CO<sub>2</sub>/GDP or CO<sub>2</sub>/capita could be interpreted as giving more "rights" to each dollar or to each people to emit CO<sub>2</sub>, this choice being disputed between countries with higher population or higher GDP. The only unambiguous ratio is dividing a unit by a reference in the same (fully comparable) unit. For example a percentage of population having access to water, a GDP or TMR growth, or a recycling rate.

The notion of critical capital gives a way to negatively prioritize "less important" problems. Solved problems can be deleted from the headline indicator lists.

### 3. Responsibility

Shared responsibilities are a growing paradigm in environmental policy. Causes and effects of environmental pressures are not always situated at the same place and time and do not always involve a unique actor. In the perspective of environmental justice, the "polluter pays" principle has been used in order to address the issue of treating environmental pressure at its early original "decision". However, it is not evident to determine the original cause of pollution. Is it the producer or the customer, or both in their mutual interest at the expense of the common good?

Severe environmental policy in rich countries may result in displacing dirty industries to third countries paid in some way "to do the dirty job", still satisfying the same demand. When global threats are concerned (e.g. CO<sub>2</sub> emissions), this environmental leakage may underpin the chances of success of global environmental policies (e.g. the Kyoto protocol). A pragmatic approach may be to make consumers assume their responsibility (to pay) for the emissions "embedded" in the products they consume. These «embedded» emissions are illustrated by the notion of ecological rucksack associated to final products (figure 2).

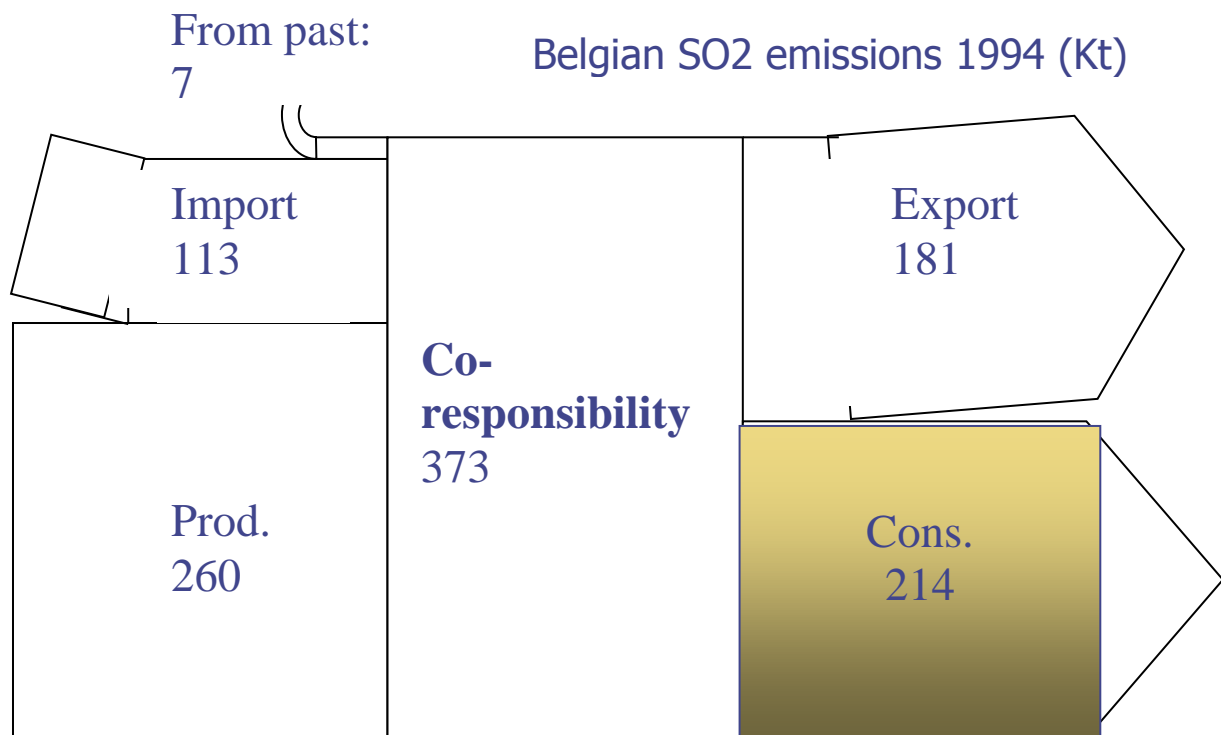


**Figure 2:** The ring of the bride with its shadow "embedded" environmental burden

Indicators are then needed to be able to evaluate the contribution of each "beneficiary" to the pollution, from the producer to the consumer including the trader all along the life cycle of the

product. Environmental accounting can trace the macroeconomic contribution to diverse environmental effects, from a producer (offer) to consumption (demand or "footprint") as illustrated in figure 3 for Belgian SO<sub>2</sub> emissions accounts.

The distribution of responsibilities and duties is a normative question that should be negotiated once the data are available. Without explicit negotiation, there is a risk of “tragedy of the commons”, each individual externalizing the ultimate environmental impacts of its decisions (production, trade or consumption) without global concern.



**Figure 3:** Potential action points for Belgium in global SO<sub>2</sub> emissions. The national emissions amounted to about 260 kt in 2004 and were the main target of environmental policy. Producers, government and households directly emitted SO<sub>2</sub> within the national borders but the policy did not consider embedded emissions in traded (or consumed) products [Kestemont, 2003].

#### 4. Equity

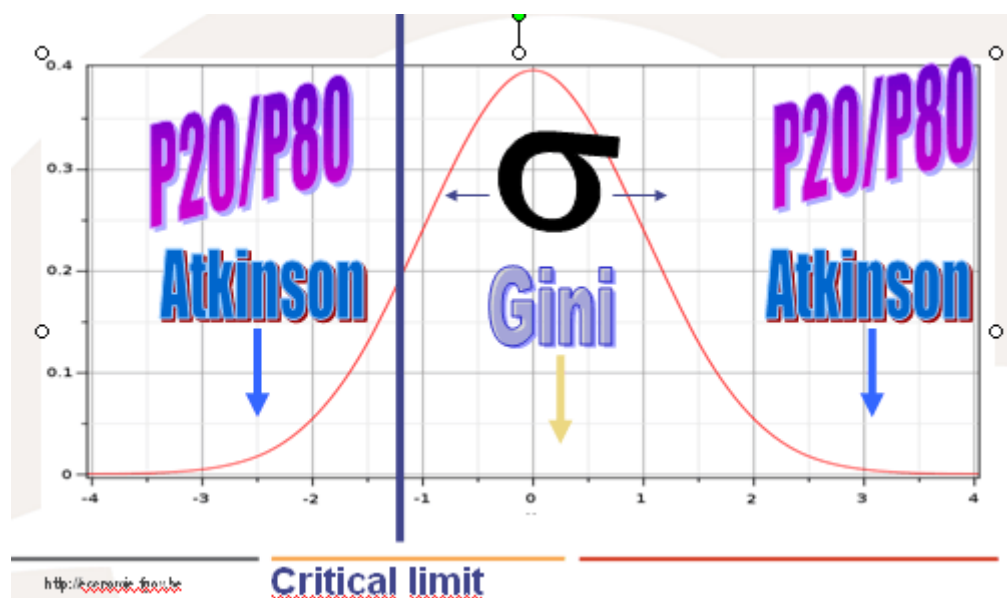
Sustainable development implies an intra- and intergenerational equity dimension [Gasparatos, El-Haram et Horner, 2008, Zaccaï, 2002]. Some minimum equity is not only an ethical question, but also a pragmatic one as argued by Sen and others. Even rich people have an economic interest in the wellbeing of their neighbours (being potential consumers or producers).

The problem of equity is not limited to shared or minimum revenues (absolute or relative poverty lines). Due to the multidimensional character of poverty and/or “limiting factors” [Atkinson, 1987, Alkire et Foster, 2009], redistribution concerns all dimensions presented above: distribution of all critical capital from producer to consumer perspectives.

There is not only one cake to be shared between people but several cakes, as illustrated in figure 4. However, specific methods may be needed to identify disparity targets (Figure 5), from the inequality coefficients (Gini, Atkinson, variance ...) to critical “poverty lines” for each of them (resource or environmental “poverty lines” or vital minimum) and percentage of population suffering from “environmental poverty” or limited access to basic critical capitals.

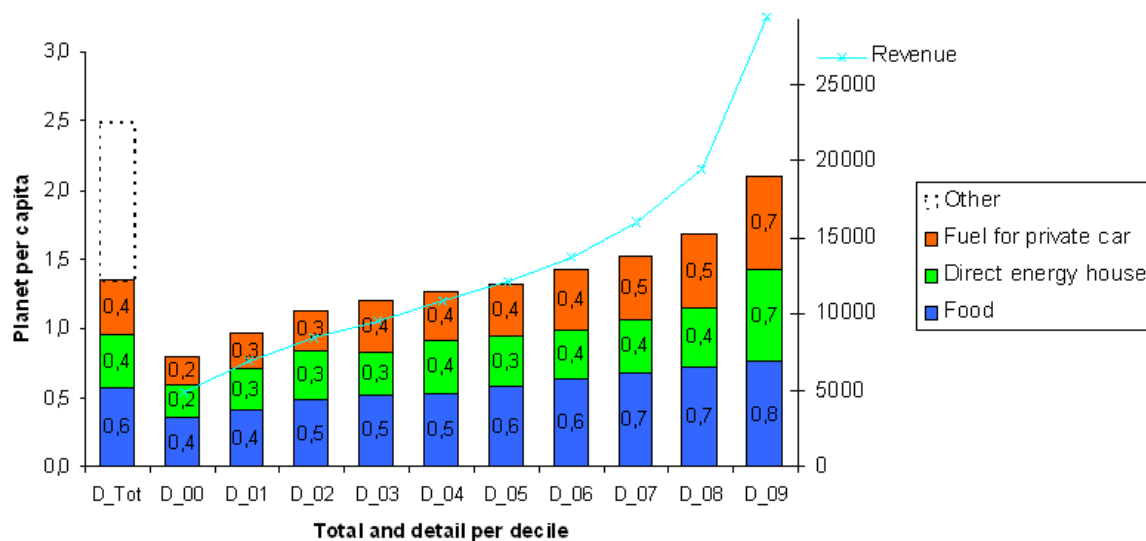


**Figure 4:** Equity = sharing the cakes



**Figure 5:** Methods are needed to indicate critical capital disparities

The relevance of environmental equity measurement can be illustrated with the example of the distribution of the ecological footprint per capita in Belgium. Despite a relatively low revenue disparity (Gini 2006 after transfer= 0.3) and a high mean ecological footprint per capita (the 4<sup>th</sup> larger in the world), there is still some domestic ecological footprint disparity for basic goods as illustrated in figure 6. The footprint disparity might be lower than the revenue disparity, but this has to be confirmed when the overall footprint distribution will be estimated.



**Figure 6:** Ecological footprint of food and final combustion per revenue deciles in Belgium 2006 (planet-equivalent per capita). About ½ of the total footprint is covered by these basic needs. Total revenue distribution is displayed for information. Source: Lepomme and Kestemont, 2012, communication to 18th Annual International Sustainable Development Research Conference, 24-26th June 2012 in Hull, UK.

## 5. Conclusion

I proposed three strong sustainability conditions and the related metrics: critical capitals, responsibility and equity considerations. Figure 7 summarizes the 3 sustainability conditions presented here, the metrics that could be used and finally the benchmarking indicator types that could be proposed. Distances to targets and number or percentages of threats (number of indicators or people beyond the critical limit) are relevant macro-indicators in this context.

OECD already pioneered indicator publications in line with the present criteria. One can mention the consumption based CO<sub>2</sub> emissions presented back to back with national emissions, and the “access to” type of indicators (percent population with access to water, water sanitation, percent population leaving in polluted areas etc).








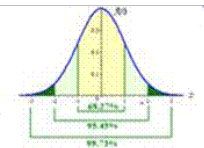
<u>Condition</u>	<u>Metrics</u>	<u>Benchmarking</u>
Limits 	MIN 	Distance to target Number of threats
Responsibility 		Distance to target Number of threats
Equity 		Disparity % threatened

Figure 7: summary

I redefine the weak sustainability as the reduction of complexity to a single dimension. There are therefore as many weak sustainability indicators as possible choices of this single dimension. Norms are unavoidable to determine implicit or explicit weighting schemes (including the choice of units in weak sustainability), the studied universe or responsibility attribution and the distribution of critical assets amongst present and future generations. Strong sustainability is characterized by the multiplicity of dimensions or critical capitals which, if exceeded one, suffice to determine the non-sustainability. The limits associated to critical capitals are relatively objectives. They are determined with some uncertainty by science, but a risk the society is ready to take has to be decided. Moreover, the distribution of the critical capitals between generations and associated uncertain risks are also subject to normative choice. However, one can imagine identifying relatively objective “poverty lines” (critical capitals at the level of individuals, called capabilities).

It appears that it is possible to identify in any calculation of sustainable development indicator, a relatively objective component of sustainability and a negotiable component of shared rights and responsibilities. This has practical utility for assessing the choice of metrics and clarifying the negotiation issues.

## References

- ABDALLAH, S., THOMPSON, S. et MARKS, N. (2008) "Estimating worldwide life satisfaction", *Ecological Economics*, **65**, **1**, 35-47.
- ALKIRE, S. et FOSTER, J. (2009) *Counting and Multidimensional Poverty Measurement*, Oxford Poverty and Human Development Initiative, Oxford, 44.
- ARROW, K. J. (1951) *Social Choice and Individual Values*, Wiley, Chapman & Hall, New York, London, 99.
- ARROW, K. J. (1978) "Extended Sympathy and the Possibility of Social Choice", *The American Economic Review*, **67**, **1**, 219-225.
- ATKINSON, A. B. (1987) "On the Measurement of Poverty", *Econometrica*, **55**, **4**, 749-764.

- BARBIER, E. B. (1989) *Economics, Natural Resource Scarcity and Development. Conventional and Alternative Views*, Earthscan, London.
- BARNETT, H. J. et MORSE, C. (1963) *Scarcity and Growth. The Economics of Natural Resource Availability*, Johns Hopkins University Press, Baltimore.
- BAUMGÄRTNER, S., BECKER, C., FARBER, M. et MANSTETTEN, R. (2006) "Relative and absolute scarcity of nature. Assessing the roles of economics and ecology for biodiversity conservation", *Ecological Economics*, **59**, **4**, 487-498.
- BLACKORBY, C. et DONALDSON, D. (1982) "Ratio-Scale and Translation-Scale Full Interpersonal Comparability without Domain Restrictions: Admissible Social-Evaluation Functions", *International Economic Review*, **23**, **2**, 249-268.
- CARPENTER, S. R., CARACO, N. F., CORRELL, D. L., HOWARTH, R. W., SHARPLEY, A. N. et SMITH, V. H. (1998) "Nonpoint Pollution of Surface Waters with Phosphorus and Nitrogen", *Ecological Applications*, **8**, **3**, 559-568.
- CLEVELAND, C. J., COSTANZA, R., HALL, C. A. S. et KAUFMANN, R. (1984) "Energy and the U.S. Economy: A Biophysical Perspective", *Science*, **225**, **4665**, 890-897.
- COMOLLI, P. (2006) "Sustainability and growth when manufactured capital and natural capital are not substitutable", *Ecological Economics*, **60**, **1**, 157-167.
- DALY, H. E. (1973) *Towards a Steady-State Economics*, W.H. Freeman, San Francisco, CA.
- DALY, H. E. (1977) *Steady-state economics*, Freeman, San Francisco.
- DALY, H. E. (1997a) "Georgescu-Roegen versus Solow/Stiglitz", *Ecological Economics*, **22**, **3**, 261-266.
- DALY, H. E. (1997b) "Reply to Solow/Stiglitz", *Ecological Economics*, **22**, 271-273.
- DIENER, E. (1984) "Subjective well-being", *Psychological Bulletin*, **95**, **3**, 542-575.
- EASTERLIN, R. A. (1995) "Will raising the incomes of all increase the happiness of all?" *Journal of Economic Behavior & Organization*, **27**, **1**, 35-47.
- EBERT, U. et WELSCH, H. (2004) "Meaningful environmental indices: a social choice approach", *Journal of Environmental Economics and Management*, **47**, **2**, 270-283.
- FLEURBAEY, M. (2008) "Beyond GDP: Is There Progress in the Measurement of Individual Well-Being and Social Welfare?" 48.
- GASPARATOS, A., EL-HARAM, M. et HORNER, M. (2008) "A critical review of reductionist approaches for assessing the progress towards sustainability", *Environmental Impact Assessment Review*, **28**, **4-5**, 286-311.
- GATELY, M. (2007) "The EROI of U.S. offshore energy extraction: A net energy analysis of the Gulf of Mexico", *Ecological Economics* Volume, **63**, **2-3**.
- GEORGESCU-ROEGEN, N. (1971) *The Entropy Law and the Economic Process*, Harvard University Press, Cambridge Mass.
- GOWDY, J. (2005) "Toward a new welfare economics for sustainability", *Ecological Economics*, **53**, **2**, 211-222.
- HARTWICK, J. (1977) "Intergenerational equity and the investing of rents from exhaustible resources", *American Economic Review*, **67**, **972**, 974.
- HEAL, G. (1998) *Valuing the Future: Economic Theory and Sustainability*, New Columbia University Press, York.
- HOTELLING, H. (1931) "The economics of exhaustible resources", *Journal of Political Economy*, **41**, **1**, 28.
- KESLER, S. E. (1994) *Mineral Resources, Economics and the Environment*, Macmillan Co, New York.
- KESTEMONT, B. (2003) "Critique des conditions de la durabilité: application aux indices de développement durable". , IGEAT-ULB, 214 pp." *Travail de fin d'études. DEA en gestion de l'environnement*, Travail de fin d'études, 214 pp.

- KESTEMONT, B. (2010) *Les indicateurs de développement durable. Fondements et applications. / Indicators of sustainable development. Fundamentals and applications*, PhD thesis, Université libre de Bruxelles, Bussels, 256.
- MARTINET, V. et ROTILLON, G. (2007) "Invariance in growth theory and sustainable development", *Journal of Economic Dynamics and Control*, **31, 8**, 2827-2846.
- MENTZAKIS, E. et MORO, M. (2008) "The poor, the rich and the happy: Exploring the link between income and subjective well-being", *The Journal of Socio-Economics*, **Article in Press, Corrected Proof**.
- NEUMAYER, E. (2003) *Weak Versus Strong Sustainability. Exploring the Limits of Two Opposing Paradigms*, Edward Elgar, Cheltenham, UK.
- PEARCE, D. W. et BARBIER, E. B. (2000) *Blueprint for a Sustainable Economy*, Earthscan, London.
- ROCKSTRÖM, J. (2009) "A safe operating space for humanity." *Nature*, **461, 7263**, 472-475.
- SEN, A. (1977) "On Weights and Measures: Informational Constraints in Social Welfare Analysis", *Econometrica*, **45, 7**, 1539-1572.
- SINGH, R. K., MURTY, H. R., GUPTA, S. K. et DIKSHIT, A. K. (2009) "An overview of sustainability assessment methodologies", *Ecological Indicators*, **9, 2**, 189-212.
- SOLOW, R. M. (1974) "The economics of resources and the resources of economics", *American Economic Review*, **64**.
- SOLOW, R. M. (1993) "An almost practical step towards sustainability", *Resources policy*, **19**, 162-172.
- SOLOW, R. M. (1997) "Reply: Georgescu-Roegen versus Solow/Stiglitz", *Ecological Economics*, **22, 3**, 267-268.
- STEVENSON, B. et WOLFERS, J. (2008) *Economic Growth and Subjective Well-Being: Reassessing the Easterlin Paradox*, Institute for the Study of Labor, Bonn, 80.
- STIGLITZ, J. E. (1997) "Georgescu-Roegen versus Solow/Stiglitz - reply", *Ecol.Econ.*, **22**, 269-270.
- TSUI, K.-Y. et WEYMARK, J. A. (1997) "Social Welfare Orderings for Ratio-Scale Measurable Utilities", *Economic Theory*, **10, 2**, 241-256.
- UNDERWOOD, D. A. et KING, P. G. (1989) "On the ideological foundations of environmental policy", *Ecological Economics*, **1**, 315-334.
- UNECE (2009) *Measuring sustainable development*, United Nations Economic Commission for Europe, new York and Geneva, 102.
- VAN DEN BERGH, J. C. J. M. (2007) *Abolishing GDP*, Free University Amsterdam, Amsterdam, 24.
- VEENHOVEN, R. (1991) "Is happiness relative?" *Social Indicators Research*, **24, 1**, 1-34.
- WACKERNAGEL, M. et REES, W. E. (1996) *Our Ecological footprint: Reducing Human Impact on the earth.*, New Society Publishers, Philadelphia.
- WORLD BANK (2006) *Where is the Wealth of Nations*, Washington D.C., 188.
- ZACCAÏ, E. (2002) *Le développement durable. Constitution et dynamique d'un projet*, P.I.E. - Peter Lang, Berne-Bruxelles, 352.

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Track 2a: Assessing and Reporting Limits in Natural and Human Systems

Paper Title: **Principles and Practices of a Politics of Sustainability Indicator Systems**

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*Abstract*

While sustainability indicator systems have proven themselves valuable rational tools for improving the information available related to the relationship of cities and communities to natural limits, the indicators movement has reached a point of realization of the limits of instrumental use of these measures in policy. Instead, an understanding of the politics of sustainability indicator systems offers potential for the conceptual and political use of indicator systems within efforts to change development trajectories toward sustainability. Considering the potential for indicator systems to be viewed as boundary objects, this paper offers an initial usability analysis of three indicator initiatives led by nongovernmental organizations within the North American context: Vancouver's Vital Signs (Vancouver Foundation), Seattle's Happiness Initiative, and LEED-ND (US Green Building Council). We find that each of the three systems has crafted a unique policy boundary within a multilevel governance scenario, implying a possibility to open up cracks in the dominant development trajectory. We also find that each system offers a different usability profile in terms of salience, credibility and legitimacy, and that trade-offs among these three criteria may exist as these systems attempt to craft utility and impact.

*Introduction: Sustainability Indicators are Positively Normative!*

Within the indicators movement, and the sustainability indicators movement more specifically, a new wave is cresting. This wave, among other things, signals an end to the days of indicators crafted in laboratories, shielded by password protected spreadsheets and cryptic formulae, and a dawn of the days of a true social theory of indicators and their utility. Social critique of indicators, of course, is nothing new (Mitchell, 2002). What is new to this current wave is the normative position of cautious confidence being taken by social scientists seeking to stake out a socially and environmentally useful policy space for indicators.

Whereas sustainability indicator systems were originally designed to alert people to approaching limits of our living systems, we are currently hitting the limits of indicator systems in promoting the change

that is recognized as necessary for a sustainability shift. Since its origins in the early 1990s, the sustainability indicators movement has produced considerable “MRV” value – measurable, reportable and verifiable (Hak et al., 2012). However, while these attributes are sufficient for the instrumental use of indicators by policymakers “directly to improve the policy outcomes in the given policy area,” (Bell et al., 2011, 10), this kind of linear application of indicators has been limited to rare cases of structured focus. Nor has instrumental use of sustainability indicators proven conducive to policy change.

Quite aside from their mostly undemonstrated instrumental roles, indicators may play conceptual roles in learning, understanding, and structuring the definition of policy problems and interpretation of trends and solutions; as well as political roles in terms of either legitimizing existing systems and structures or disrupting these dynamics. These conceptual and political roles for indicators speak to the potentially valuable position of indicator systems within contemporary governance as ‘boundary objects’ (Star and Griesemer, 1989) which may be intermediary between different policy actors, and thus operate at new policy boundaries; between policy design and implementation; data inputs and trend outputs. We lack an adequate understanding of or approach to using indicator systems as such boundary objects, however. What this points to is a need, and perhaps a readiness within the field, to develop “the governance of indicator processes” (Bauler 2012, 41).

In the interest of advancing this agenda, this paper suggests principles for a reflexive politics of sustainability indicators. Recent research by Bauler (2012) has advocated just such a path, focusing on evaluation of indicator systems’ “usability profile.” Usability is defined as: “the inherent, mostly implicit, potential of indicators to be considered by policy actors during their decision activities” (Bauler, 2012, 39). Usability analysis is proposed as a deliberative process of determining this utility of indicators at a series of different boundaries between different interacting groups in the policy realm. There are three core analytical elements<sup>1</sup>: legitimacy, credibility and salience. Each of these elements may be assessed differently by actors from different positions, so we need to focus usability analysis on particular policy boundaries being operationalized by an indicator system.

#### *Indicator System Usability in the face of Multilevel Governance for Sustainability*

Effective research into the politics of sustainability indicators entails the search for a deeper understanding of the different roles that indicator systems may play as we insert them into different governance contexts, layered upon claims and policies specific to sustainability. The abundance and complexity of information related to any city’s sustainability agenda implies that indicators audiences always have options about whether to accept the information on offer. More than options, this situation entails an expectation that indicators audiences will make judgments to reconcile the multiple and often conflicting pieces of information that constitute their own understanding of the context. From the point of view of those offering the indicator system up as new information, this situation demands that rhetoric and politics, rather than solely scientific authority, be employed in order to secure the usability of the system.

However unlikely the assumption of direct uptake of new indicator-based information into policy processes in areas of singly defined policy responsibility, this becomes even less likely in contexts of multilevel governance: there is too much complexity, too many diverse opinions, contrasting positions, and a lack of similar or overlapping discursive frames (Bauler, 2012). Suffice to say that policy issue areas of sustainability are always subject to complex multijurisdictional governance arrangements, from international pressures to individual self-governance. On top of this, as policy issue area definition approaches the integrative ideal of sustainability (Holden, 2006a), available data becomes increasingly scarce and requires more boldness and persuasive inference to draw conclusions and posit solutions (Michalos 2011; Michalos et al., 2010).

The operationalization of a politics of sustainability indicator systems in this context of multilevel governance will be demonstrated here through a usability analysis of three systems in the North American context: Vancouver's Vital Signs, Seattle's Happiness Initiative, and the LEED-ND (Leadership in Energy and Environmental Design for Neighborhoods) system. Each of these three projects represents innovation in terms of characterization and operationalization of the most effective policy boundary. None is a government actor; each represents a different new governance actor – the philanthropic sector, the nongovernment sector, and the professional organization sector – and all operate at multiple scales, local or regional, national or international, and places in between. Importantly, in terms of the crafting of new policy boundaries, none sees government as the primary audience target of their work: for Vital Signs and the Happiness Initiative, the primary audience is the public at large, with local government consulted or engaged to different lesser degrees; for LEED-ND, the primary audience is the building industry, although the public is a key additional audience. Depending on one's perspective, this could be seen as a neoliberal sleight of hand, bypassing the democratic governance system to our peril; or, alternately, bootstrapping across the growing gap between the limitations of government to respond to evolving community needs and desires and a maturing social movement and improving broad-based understanding of the mechanics of real social change at the community scale. Also, each initiative represents a completely separate and non-overlapping attempt to leverage change via an indicators-based approach: engagement from a basis of a community well-being report card, the assertion of happiness as core development goal, and a voluntary sustainability standard for physical development.

In addition to an analysis of the policy boundary being operationalized, the usability analysis will consider the following three core criteria:

1. Salience: do the indicators refer to the questions deemed relevant by the policy actor, adequately assess the policy stakes?
2. Credibility: policy actors' valuation of the robustness of indicators
3. Legitimacy: are the indicators configured with procedural fairness to meet political, societal and ethical standards?

**Case 1: Vital Signs for Metro Vancouver** (<http://www.vancouverfoundationvitalsigns.ca>)

Launched in 2006, the Vancouver Foundation's Vital Signs project is intended to bring together new, in-depth, critical and verifiable information about Vancouver's communities in an innovative process that includes region-wide engagement, primary and secondary research, web-based and print publication, and outreach. It represents the Vancouver region's contribution to the Vital Signs initiative which is headed by the umbrella organization for community-based philanthropic organizations in Canada, Community Foundations of Canada.<sup>2</sup>

The Vital Signs for Metro Vancouver project has been conducted five times. With an overall reporting theme expressed variably as liveability, wellness and community vitality, the initiative reports on indicators and trends in 12 theme areas (with some variations): children and youth, seniors, belonging, economy, housing, affordability, getting around, environmental sustainability, safety, learning, health and wellness and arts, culture and leisure. In 2010, the most recent year that the initiative was conducted, a total of 238 indicators were reported, along with public opinion survey results, based upon a representative sample of Vancouverites with subregional breakdowns, and citizen grades and priorities in each theme area.

Established in 1943, the Vancouver Foundation is the largest philanthropic community foundation in Canada, with endowment funds totalling over \$750 million (Vancouver Foundation, n.d.). As a step away from 'front-line' engagement with grant recipients to lead a process in attaining a representative, research-based perspective on key trends, the project represents a first for the community foundation.<sup>3</sup> In other words, the project presents a new *policy boundary* frontier for the community foundation, in which the foundation is actively seeking to gather new knowledge about the communities in which they work, with a view to this information improving their ability to assist these communities.

One of the strategic objectives stated by the Vancouver Foundation for the work is "to help us understand our community. By knowing where metro Vancouver does well and what challenges we face, we are able to put our funding and resources in the areas of most need and celebrate the accomplishments in our region as a community foundation" (Kubota, 2010). This role has been noted with interest as part of a larger move toward 'place-based' philanthropy in which funders seek to understand the places in which they offer funding with an intent to create the understanding needed to address the root causes of social and environmental problems (Murdoch et al., 2007). It has also been called into question by social researchers interested in the impact of devolution of authority to intermediary organizations between government and citizens, leading in the delivery of areas of policy where government once held exclusive authority (Ostrower & Stone, 2007).

Although organizations involved in data and reporting throughout the region were initially unsure about the need for Vital Signs, the project's *salience* could be judged in terms of the eventual willingness of community leaders, from local and regional government, business, and nongovernment organizations, to participate in the initiative's leadership and expert advisory groups, and indeed the willingness of several of these organizations to share data, to distribute the report, and contribute in other ways to its success. The VS report is intended to be public-friendly, even amongst a data averse public. There has been widespread recognition throughout the Vancouver region that Vital Signs has value, that

Vancouver Foundation offers a service to the region in conducting it, and key connections with the major local newspaper, the *Vancouver Sun*, have ensured wide awareness of the report and key highlighted indicator trends amongst the general public. The answer to the question of what to do with this information source, however, has not been so readily forthcoming. In 2010, the Foundation initiated deeper engagement with the project among foundation staff, including organizing a 'dotmocracy' workshop in prioritizing indicators. Further specific connections between the report's findings and organizational funding priorities are more tenuous. Also in 2010, the Foundation took the report "deeper" into the region's suburbs through a series of face-to-face events called Community Conversations. What may come of the Vancouver Foundation and Vital Signs taking on this kind of convening leadership role, in asserting its strategic position and taking its original research into a direct interface with the public, remains to be seen.

Given that Vital Signs is a data-rich project driven by people with no particular knowledge of or affinity to data, *credibility* has been key to project design. The project work has been conducted by a project team within the Foundation, guided by the organization's Board of Directors, who have worked with external voluntary advisory groups, research organizations, and a communications firm. The report covers the geography of the metropolitan Vancouver area, but also includes many disaggregated indicators at municipal and subregional scales. Additionally, Vital Signs features an opinion poll of a representative sample of Vancouverites, which probes residents' perceptions on different key questions within the realm of liveability and vitality.

Vital Signs for Metro Vancouver offers a number of significant innovations within community quality of life indicators practice, aimed at achieving high levels of *legitimacy*. Key among these is the pairing of indicators, based on secondary data and analysis, with thematic grades, and action priorities, which are gathered via a citizen survey. Innovations in report dissemination include a move toward more effective use of an animated web format for reporting, along with social media engagement during the process of the initiative.

## **Case 2: Seattle Happiness Initiative**

The Happiness Initiative began in 2011, as the fifth cycle of the Sustainable Seattle indicators of sustainable community project. Garnering inspiration both from the notion of the "unalienable right" of citizens to the "pursuit of happiness" within the American Declaration of Independence, as well as the Kingdom of Bhutan's Gross National Happiness initiative, the Sustainable Seattle Happiness Initiative quickly spun into a stand-alone national nonprofit organization, the Happiness Initiative. The Happiness Initiative has designed and tested a version of the happiness survey that can be completed in 15 minutes, and created 'Happiness Initiative Toolkits' to facilitate groups, from private sector organizations, to municipal governments, to university classes, to families, in conducting their own survey. About 2,600 Seattle residents of a total 7,200 respondents from across the US have responded to the voluntary or 'opt-in' web-based survey. Seattle's 2011 Happiness Report Card thus serves as a prototype for other areas initiating "happiness work" across the US.



The *policy boundary* engaged by the Happiness Initiative sits at the civil society/local government nexus, with Seattle City Council offering an official proclamation of support for the initiative from its outset (SAHI 2011, 3).<sup>4</sup> Funding from the city's Department of Neighborhoods and the help of local immigrant services organizations facilitated the participation of immigrants in the survey. The Happiness Initiative is hopeful that funds will be allocated within the City of Seattle 2013 budget for a representative sample survey (Musikanski, 2012a).

There is also a national and international civil society and social movement boundary being engaged, with Happiness Initiative engagement in the United Nations High Level Meeting for Wellbeing and Happiness: Defining a new economic paradigm in New York on April 2-4, 2012 (Musikanski and de Graaf, 2011a). "Practical policy recommendations" regarding the emergence of a more holistic approach to development emerging from this conference will be taken forward to the June 2012 Rio plus 20 Earth Summit (Astor 2012). In the United States, the organization hopes to launch a Happiness Collaboratory with one or more specific demographic groups or sectors, in order to examine potential refinements to the survey, issues specific to happiness among, say, youth or business people, and to enrich the public conversation about shifting values around progress in that way (Musikanski, 2012a).

The initiative is motivated by a perceived need to increase the *salience* of the sustainability-oriented and indicators-based approach pioneered by Sustainable Seattle. Cofounder Laura Musikanski expresses it this way: "Here we are, Sustainable Seattle, an organization that changed the world, and yet it hasn't created real change" (Musikanski, 2012b). The salience of this initiative thus derives from identifying the unifying theme of happiness, with a high level of personal purchase, albeit differently defined across cultural contexts, the underlying challenge to an economic paradigm that deprives people of happiness, added to the approach of a measurement and monitoring approach based upon crowd-sourced, subjective data.

This approach means limitations to *credibility*, an intentional choice on the part of the initiative based on the underlying sense that "it isn't going to be experts who change the world." In looking back at the objective indicators selected and objective data reported by Sustainable Seattle, initiative founders' reflections were that: "This information was important and helpful to policy makers, but the sheer number of indicators and their 'objective' quality made them increasingly less engaging for the public and the media." (SAHI 2011, 6) To fix this, they set out to design a model that was personally engaging across a diversity of members of the public, "– from kids to grandmas, sustainability experts to business managers and politicians, neighborhood groups or multinational enterprises –" (Musikanski, 2012b). The notion of 'real' happiness, "not happiness in terms of instant feeling but in terms of overall satisfaction with life," connected this need for immediate personal relevance and identification with the need to reorient or rediscover values in a time that is challenging conventional understandings of economic success. The Happiness Initiative, thus, seemed to founders to offer an opportunity to facilitate, popularize, and defend a personal reformulation of happiness and the means to attain this enrichment, quite separately from income gains and material standard of living: "Across the world, 'happiness' means different things in different cultures, but some things are clear no matter what the culture: the

influence of hyper-consumerism, poverty and resource depletion means deleterious effects to everyone's well-being, sustainability and happiness." (Musikanski and de Graaf, 2011b)

While the sample size for the Seattle area on the initial run of the opt-in survey was large, the sample was biased towards women (two-thirds of respondents) and those with higher than average income and education. The project organizers offer the following defense of their approach: "While we acknowledge limitations in our data, we believe that the Happiness Initiative survey reveals important trends which will be valuable to Seattle residents and policy makers, and that further work on the Happiness Initiative, including ongoing opt-in surveying and a representative survey, is warranted." (SAHI, 2011, 7) The organization, however, does see partnering with a representative and objective data source to be critical to its future trajectory.

### **Case 3: LEED for Neighborhood Development (LEED-ND)**

Developed as a new rating system for neighbourhoods, LEED-ND was piloted in 2007 and launched in 2009. It is the first standard in the LEED family to move beyond the scale of individual buildings, in recognition of the notion that "a building is only as green as its surroundings" (US GBC 2012, 3). A rating system which "distills the experience of leading professionals in environmental policy and the building industry ... into objective, measurable criteria," (US GBC, 2012, 5), LEED-ND includes three dimensions of evaluation, each of which has both prerequisites and optional point credits. The three domains are: smart location and linkage ('where to build,' disqualifying environmentally sensitive sites), neighbourhood pattern and design ('what to build,' prohibiting gated and low-density communities), and green infrastructure and buildings ('how to manage environmental impacts of building,' preventing pollution during construction). A review of the pilot phase found 205 certified projects in the United States, 24 in Canada, 6 in China and 1 each in Bahamas, South Korea, and Mexico; 91% were in urban areas (Criterion, 2007).

The *policy boundary* at which LEED-ND operates is primarily that between the building professions and the environmentally-conscious (property buying) public. The LEED-ND rating system "is intended to capture the interest of both the public and private sector in looking beyond the individual building to the larger community" (US GBC, 2012, 3). LEED-ND offers a value proposition to the environmentally-concerned public, a case made in the Citizens' Guide to LEED for Neighborhood Development: "While LEED-ND is not a guarantee that you [the member of the public] will approve of every aspect of a project, it is a very good indication that a project's environmental performance will be superior to average development" This is followed up with the suggestion that "If [a development proposal] does not appear to be certifiable at any level, consider opposing it" (Welch et al., 2011, 17). The role envisioned for LEED-ND in the hands of an engaged public relies primarily on the personal responsibility accrued from investment of time and money rather than a traditional understanding of citizenship: "Community members involved in planning for a neighborhood's future are often more likely to invest in it, care for it, and maintain it. This sort of personal investment supports a neighborhood's long-term stability and sustainability. If new development or other major changes are proposed in a neighborhood, basic facets of community involvement should include meetings with surrounding property owners,

residents, and businesses; modifying project designs to meet stated community needs; and maintaining open lines of communication throughout the project” (Welch et al., 2011, 13).

However, the obvious overlap with traditional planning activities of local governments has not been lost on the makers of LEED-ND. With the publication of a “white paper” for local government adoption and adaptation of LEED-ND in 2012, the Green Building Council has also turned toward the policy boundary it shares with local government: “LEED for Neighborhood Development allows local governments to achieve market transformation at a greater rate than ever before by making the “greenness” of a building as much about where it is as what it is.” Citing the tool as a “ready-made set of environmental standards for land development” (Welch et al., 2011), the use of LEED-ND as a template for green development ordinances is promoted.

The *salience* of LEED-ND is clear, and sits in an obvious upward trajectory from the LEED building rating tools. Applying LEED-ND to the site planning and build out of precinct scale areas is expected to improve energy and water efficiency, to “revitalize existing urban areas, reduce land consumption, reduce automobile dependence, promote pedestrian activity, improve air quality, decrease polluted stormwater runoff, and build more livable, sustainable communities for people of all income levels” (USGBC 2007, 1)<sup>5</sup>.

However, at the level of *credibility*, these high level claims are questionable. A key example is the very tentative relationship of LEED-ND to affordable housing: “When housing is available at affordability [sic] range of prices, people who earn less but are vital parts of the community – such as teachers, police officers and public sector employees, or artists – can live and work in the same community as those with higher incomes. This encourages economic opportunity and social diversity, and can sometimes reduce commute times by allowing people to live closer to work” (Welch et al., 2011, 8). The makers of LEED-ND have nothing to say about the importance of housing those who may not fit the bill of either essential workers or cultural creatives and offers very little credit for affordable housing provision of any kind (Garde, 2009).

In an academic evaluation of US pilot projects, respondents viewed the LEED-ND rating system as valuable for “verifying the sustainability of neighborhood development projects” (Garde, 2009), generating publicity, garnering market advantage, and brokering a sense of comfort among planners and local officials in the project approval process. Some also criticized the rigidity of the points-based system; one said “the costs greatly overshadow the benefits” with the award of certain points being entirely cost prohibitive (Garde, 2009). In this evaluation, most respondents said that they made no changes to their design or building plans to meet LEED-ND criteria.

LEED-ND faces a *legitimacy* challenge in that it and other LEED rating systems are built and offered up by the sector that benefits the most from the construction of new developments: the design and building sector. LEED-ND confronts this challenge in some respects via its partnership with the Congress for the New Urbanism and the Natural Resources Defense Council. Still, from a strict materials throughput perspective, the most sustainable neighbourhood is one that is repurposed from existing stock rather

than built anew, and new build is the only aspect addressed by LEED-ND. This bias, and other necessary biases in the selection of prerequisite and point items for certification, add to the cost of LEED certification and ensure the need for new channels of professionalization in order to support the certification process, leading some within the housing industry to refer to the “tyranny of LEED” (Rennie, 2011). In the Citizens’ Guide, the intent of increasing the spread and use of LEED-ND as a standard in this way is not hidden: “(If you belong to an organization or agency that already maintains guidelines for which projects to support, it might be helpful to refine or augment those guidelines with standards from LEED-ND.)” (17). There is an efficiency argument offered for this attempt to spread the reach of LEED-ND: “It can be a struggle for local citizens, designers, planners and governments to create feasible standards for sustainable development on their own. LEED-ND has the potential to fill this gap with criteria that have been developed in a consensus process and field-tested in various contexts” (Welch et al., 2011, 22).

### *Comparative Usability Analysis*

In comparative perspective, we find that the three projects have crafted different policy boundaries and exhibit different usability profiles (Table 1). What each of these systems offers is, if not an open window, at least the possibility of cracks in the dominant development path. Despite the dominant ‘postecological’ notion that no systemic alternatives exist to the political-economic system in which we find ourselves, the Happiness Initiative offers a straightforwardly value-based proposition that a shift away from affinity to this system can help individuals live better with less, in an environment where this is message has visceral local and international salience. Despite an increasingly blatant assault on government’s ability to collect and use key social and environmental data for policy, the philanthropic sector has stepped up and asserted through Vital Signs that this role is important and can be accomplished by other sectors and other means. Despite cynicism about the governmentalization, colonialization and commercialization intentions within standards such as those for sustainable building and neighbourhood development, we do see the green building standards system coming to terms with the need for engagement and adaptation by local people and local government as well as design and building professionals, and a variety of political as well as instrumental uses for the tool.

**Table 1. Usability Analysis of Three Nongovernmental Indicator Initiatives**

	<i>Key operational policy boundary</i>	<i>Salience</i>	<i>Credibility</i>	<i>Legitimacy</i>
<b>Vital Signs for Metro Vancouver</b>	Philanthropic foundation – local public	LOW	HIGH	HIGH
<b>Happiness Initiative</b>	Nongovernment organization – local and global public	HIGH	LOW	MEDIUM

<b>LEED-ND</b>	Building industry – local public (local government)	<b>HIGH</b>	<b>MEDIUM</b>	<b>LOW</b>
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These results also tell us something about the way in which the salience, credibility, and legitimacy features of usability interact. We find that salience can exist in a trade-off or negative feedback relationship with credibility (in the case of the Happiness Initiative) and that the three initiatives have a different approach to ‘shallow’ or ‘deep’ framing, in terms of connecting the initiative with a set of larger-than-self values (Lakoff, 2004; Crompton, 2010). The Happiness Initiative is the most ‘deeply’ framed, connecting the attainment of a richer sense of happiness, defined by subjective measures of well-being, with the eschewal of strict material well-being. The Vital Signs project, in and of itself, is framed ‘shallowly,’ offering no specific notion of what constitutes well-being or what should be done to improve it, and no direct route to policy uptake. This may suggest a trade-off relationship between salience and legitimacy, with deeper framing offering more public salience, but with potential losses to policy legitimacy. LEED-ND is in an intermediate position, given that the measures do add up to a value that corresponds to a standardized level of achievement, and that level of achievement is associated with a particular vision of a sustainable community development, set apart from a typical new development. Beyond questions of site location, physical design, and technologies and materials used in construction, however, LEED-ND does not dip into the pool of human values explicitly in order to argue its position, faces a number of apparent contradictions in its position with regard to community sustainability, and loses some amount of salience in this way.

### **Discussion: Adding Up New Behaviours at the Boundaries**

The crisis of indicators within the sustainability movement is a simultaneous crisis of salience, credibility and legitimacy. In the dimension of salience, there is considerable cultural bias in definitions of wellbeing, happiness, and sustainability, much of which is unspoken and not open for meaningful debate. Systems can be eternally questioned regarding their credibility, as no baseline or reference point for sustainability is accepted by all, trade-offs with immediate economic and social impact are often apparent, and widespread sophistication in manipulating numbers in different ways to derive different numerically credible results is rampant. The climate of legitimacy is fraught with extreme mistrust and confusion, and this accelerates as the need for social change becomes increasingly obvious, and increasingly resisted.

Agile adaptation and surprise need to be employed on all three fronts, and the operationalization of new policy boundaries is a key means to this end. At any given policy boundary, knowledge gaps emerge between arenas and actors, for instance between ‘science knowledge’ and ‘policy action’, which can make the first ineffective and unused, and the second not respond correctly to upcoming challenges. While indicators may fail in instrumental application because they do not belong to any particular policy sphere in multilevel governance scenarios, their boundary-crossing capacity may lend them specific utility at the gaps and overlaps between different policy spheres. As boundary institutions, indicator

systems would “help to construct a web of commonly shared norms, conventions and rules across different policy arenas. How indicators are interacting with science, policy and society arenas depends on the way they are configured with regard to the different arenas” (Bauler 2012, 43).

All three of the indicator system approaches examined here embed an understanding of the need to create demand for these indicators as part of the challenge of driving change. This is part of the wager involved in cultivating new policy boundaries for the creation and use of these systems. To the extent that these systems are employed in a way which does, in fact, cultivate demand both for the indicators and for the changes in policy and practice implied by the indicators, these systems address a common shortcoming of traditional indicator systems, namely the assumption of demand in situations where the same agency may be the primary creator and user of the information. From the perspective of boundary organizations, indicator systems can be thought of as the means of crossing boundaries and carrying discourses, information, and priorities across different policy divides.

Boldness is required in order to make the leap between where we are and where we need to be in a wide range of domains of life. This is risk-taking work, not the forté of most statisticians; many non-governmental organizations, by contrast, are well poised for this (Brulle, 2010). Work in this sphere requires a more reflexive, connected understanding of the relation between the process of indicator system design and its use. Bauler (2012, 39), in this vein, has gone so far as to suggest that an indicator system’s usability is dependent on “the intermediary moment between indicator construction and indicator use.” In particular, this role for indicators work implies a need for openness and transparency. As determined by the POINT Project: “Such efforts could not only increase the relevance of the indicators for the various policy actors, but would also reduce the risk that indicators are used to conceal rather than illuminate policy issues” (Bell et al., 2011, 6) and encourages the exposure of the mechanisms and patterns underlying the way in which different actors behave in policy contexts. The demand for open debate about values and core directions means that if indicators are to be part of a change in development trajectory, they need to be “used in terms of enlightenment, informing problem framing, informing world views or influencing values, or in other words in a wider perspective of social or collaborative learning” (Bauler, 2012, 39).

These systems share some measure of success despite rather different usability profiles, a common challenge of operating outside of formal government within a multilevel governance system, . While none offers a perfect process for emulation, each of these systems demonstrates certain advances in terms of engagement in the politics of contemporary urban sustainability discourse and debate. Explicit attention to the politics of sustainability indicator systems has the potential to improve the results of these and other systems in their further embedding within urban policy.

## References Cited

Astor, M. 2012 (2 April) UN discusses creation of Gross National Happiness. *Seattle Times*.  
[http://seattletimes.nwsourc.com/html/nationworld/2017895408\\_apununhappinessconference.html](http://seattletimes.nwsourc.com/html/nationworld/2017895408_apununhappinessconference.html)

- Bauler, T. 2012. "An analytical framework to discuss the usability of (environmental) indicators for policy." *Ecological Indicators* 17: 38-45.
- Bell, S., K. Eason and P. Frederiksen (eds.) 2011. POINT: Policy use and influence of indicators. A synthesis of findings of the POINT Project. The Bayswater Institute.
- Criterion Planners. 2007 (Oct). LEED for Neighborhood Development Characteristics of Pilot Projects. US Green Building Council. <http://www.usgbc.org/ShowFile.aspx?DocumentID=3773>
- Crompton, T. 2010. Common Cause: The case for working with our cultural values. Surrey: WWF UK.
- Garde, Ajay. 2009. Sustainable by design? Insights from U.S. LEED-ND pilot projects. *Journal of the American Planning Association* 75(4): 420-440.
- Hak, T., B. Moldan, and A.L.Dahl. 2012. Editorial. *Ecological Indicators* 17: 1-3.
- Holden, M. 2006a. Urban indicators and the integrative ideals of cities. *Cities* 23(3): 170-183.
- Holden, M. 2006b. Sustainable Seattle: The case of the prototype sustainability indicators project. In J. Sirgy, D. Rahtz, and C. Patterson (eds.) *Community Quality-of-Life Indicators: Best Cases II*. New York: Springer-Verlag.
- Kubota, M. 2010 (24 September) Blog post: Thank You Vancouver Timeraiser. <http://vfvitalsigns.wordpress.com/page/2/>
- Lakoff, G. 2004. *Don't Think of an Elephant!* White River Jntn, VT: Chelsea Green.
- Michalos, A. (2011) What did Stiglitz, Sen and Fitoussi get right and what did they get wrong? *Social Indicators Research* 102: 117-129.
- Michalos, A. et al. (2010) *An Approach to the Canadian Index of Wellbeing*. Toronto: Atkinson Charitable Foundation.
- Mitchell, T. (2002). *Rule of Experts: Egypts, techno-politics, modernity*. Berkeley: University of California Press.
- Murdoch, J. et al. (2007). The place-based strategic philanthropy model. Dallas: Centre for Urban Economics, Univeristy of Texas at Dallas.
- Musikanski, 2012a (23 May). Personal communication.
- Musikanski, L. 2012b (12 April). The UN embraces the economics of happiness. Yes! Magazine <http://www.yesmagazine.org/happiness/the-un-embraces-the-economics-of-happiness>
- Musikanski, L. and J. de Graaf. (2011a, 3 Aug). Moving forward on the Happiness Initiative. CSRwire: <http://www.csrwire.com/blog/posts/84-moving-forward-on-the-happiness-initiative>

Musikanski, L. and J. de Graaf. (2011b, 12 Oct). Happy in Hungary: Fifty leading sustainability experts explore the secret to happiness. CSWire: <http://www.cswire.com/blog/posts/172-happy-in-hungary>

Ostrower, F. & Stone, M.M. (2007). Acting in the public interest? Another look at research on nonprofit governance. *Nonprofit and Voluntary Sector Quarterly*, 36, p.22.

Rennie, B. (2011, 14 Dec). Personal communication.

Seattle Area Happiness Initiative. 2011. Happiness Report Card for Seattle. Online at: [http://www.happycounts.org/wp-system/wp-content/uploads/downloads/2011/11/Seattle-Happiness\\_Report\\_Card-2011.pdf](http://www.happycounts.org/wp-system/wp-content/uploads/downloads/2011/11/Seattle-Happiness_Report_Card-2011.pdf)

Star, S.L. and J.R. Griesemer. 1989. Institutional ecology, 'translations' and boundary objects: amateurs and professionals in Berkeley's Museum of Vertebrate Zoology, 1907-39. *Social Studies of Science* 19(3): 387-420.

US Green Building Council. 2012. A Local Government Guide to LEED for Neighborhood Development. Updated April 2012. US GBC.

Vancouver Foundation. (no date). About Us – History. <http://www.vancouverfoundation.ca/about/history.htm>

Welch, A., K. Benfield, and M. Raimi. 2011. A Citizens' Guide to LEED for Neighborhood Development: How to tell if development is smart and green. Washington: Raimi + Associates and Natural Resources Defense Council.

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### End Notes

<sup>1</sup> Additional components for a complete usability analysis recommended by Bauler (2012) include: participation, science and governance, and focus.

<sup>2</sup> As of 2012, 22 communities across Canada had participated in Vital Signs, with considerable variation in the approach taken and results achieved. While the Vital Signs initiative is now led by the Community Foundations of Canada, it originated as a local project of the Toronto Community Foundation (TCF) in 2001, where the TCF was identified by other local leaders as the organization best situated to track and report on key metropolitan trends at a critical juncture for that city.

<sup>3</sup> Although, beyond the Vital Signs initiative, philanthropic foundations elsewhere, such as the Boston Foundation, have undertaken similar community indicators work.

<sup>4</sup> This proclamation was advanced by Seattle City Council president Richard Conlin, himself one of the founders of Sustainable Seattle in 1990 (Holden, 2006b).

<sup>5</sup> In response to the deficiencies and 'low-balling' approach to LEED certification in the design and construction industry, the Living Building Challenge was launched in 2010 as a much higher standard for sustainable building.



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This standard, now administered by the International Living Building Institute, currently has about 140 active registered projects and three fully certified living buildings.

# The conditions for strong sustainability

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Track 2a: Assessing and reporting limits in natural and human systems

Oral

## Abstract

Weak sustainability and strong sustainability imply different aggregation functions that involve different assumptions of substitutability between factors. Weighting is always normative. It may be explicit or may consist of the selection of a single unit or dimension. I redefine weak sustainability as the reduction of complexity to a single dimension. There are therefore as many weak sustainability indicators as possible choices for this single dimension. Strong sustainability is characterized by the multiplicity of dimensions or critical capitals which, if any are exceeded, suffice to determine the non-sustainability. It appears that it is possible to identify in any calculation of a sustainable development indicator, a relatively objective component of sustainability and a negotiable component of shared rights and responsibilities. This has practical utility for assessing the choice of metrics and clarifying the negotiation issues.

**Keywords:** strong sustainability, critical capital, aggregation, indicator, negotiation, responsibility, distribution, equity

## 1. Introduction

Strong and weak sustainability have been widely discussed and have lead to a quantity of indicators [Daly, 1997a, Zaccai, 2002, Neumayer, 2003, Pearce et Barbier, 2000, Daly, 1997b, Stiglitz, 1997, Solow, 1997]. Following the weak (or neoclassical) perspective, sustainability is determined by the conservation of utility or consumption level, which is a function of the production ultimately determined by the total capital including economic, social and natural capitals [Solow, 1974, Solow, 1993]. Sustainability is a question of maximising total utility (or consumption) on an infinite time [Martinet et Rotillon, 2007, Heal, 1998].

Consider a set  $KS$  of *substitutable* capitals  $k_j$ ,

$$KS = \{k_1, k_2, \dots, k_n\}$$

Let  $k$  be the sum of substitutable capitals

$$(1) k = \sum_{i=1}^n k_i$$

and let  $k'$  be the growth of total capital

$$k' = k_t - k_0$$

The generalized condition of weak sustainability is [Kestemont, 2010]:

$$(2) k' \geq 0 \quad \text{Total capital should not decrease}$$

Note that it is the total capital per capita that should not decrease [UNECE, 2009]. The fair distribution of this total capital (or at least of the related utility) can further be discussed. One can fix an individual poverty line [Blackorby et Donaldson, 1982] or only consider the global situation [Solow, 1974]. In the latest case, the individual threshold is implicitly equal to zero, the distributional problem being considered a normative or ethical (not scientific) question.

Expressed in monetary unit per capita, a typical example of weak sustainability indicator is the genuine savings (or adjusted net savings ANS) [World Bank, 2006]. The uncertainties and ethical positions relative to the monetary indicators including GDP are largely commented [Gowdy, 2005, Abdallah, Thompson et Marks, 2008, Diener, 1984, Veenhoven, 1991, Easterlin, 1995, Mentzakis et Moro, 2008, Stevenson et Wolfers, 2008, van den Bergh, 2007, Fleurbaey, 2008].

The choice of the single monetary unit is not so simple in practice in a real "imperfect" market. One has to choose a reference currency, a base year for prices, a weighting scheme for purchasing power parities etc. Perfect substitutability does not imply using a monetary unit to express economic capitals or flows. Other units like energy (or exergy) content or tons of materials could be preferred (haberl, Kestemont). Biosphere protectors prefer to use the global hectares of biocapacity and the related ecological footprint. All these initiatives pertain to the weak sustainability metrics. Actually, there are as many "sustainability" indicators as authors and points of views. The choice of the unit and/or the weights is always a normative choice that can be easily criticized. Another problem in the "total capital" approach is that unknown capitals are implicitly weighted zero. New "discoveries" of previously neglected of unknown capitals (like natural capitals) and their internalization would lead to an erroneous impression of sustainability (apparent total capital growth).

Let  $w_j$  be non-negative weights of perfectly substitutable capitals

$$W = \{w_1, w_2, \dots, w_n\},$$

$$\sum_{j=1}^n w_j = 1, w_j \geq 0 \text{ pour } j = 1, \dots, n.$$

The weighted arithmetic mean of capitals,  $A(k)$ , is :

$$(1') \quad \bar{k} = A(k) = \sum_{j=1}^n w_j k_j$$

Let the growth of mean capital be

$$\bar{k}' = A(k_t) - A(k_0), (t = \text{at time } t, 0 = \text{at initial time})$$

The condition for weak sustainability (2) becomes

$$(2') \quad \bar{k}' \geq 0 \quad \text{The mean capital should not decrease.}$$

A policy of weak sustainable development is to maximize the average capital

$$(3) \quad \max \bar{k}'$$

For strong sustainability, there is a natural limit whether in the form of the irreversibility of certain natural changes (laws of thermodynamics) or in absolute scarcity [Daly, 1977, Barbier, 1989, Barnett et Morse, 1963, Underwood et King, 1989, Baumgärtner et al., 2006, Georgescu-Roegen, 1971]. Species extinctions and radioactive contamination are example of irreversible phenomena. These limits can be simple (direct), as in the case of the exhaustion of a gas tank or complex (combined) when multiple sources and products come into play, as for the control of a fire or survival of a species. These limits may be absolute or relative to space (density, concentration), time, speed (change), the container (specific resistance). For example, the toxicity of this substance to the nature or the human being determines local limits.

In this paper, I propose three principles as a framework for selecting sustainability indicators: strong sustainability, responsibility and equity.

## **2. Sustainability: critical capitals**

### **2.1. Conditions for strong sustainability**

Consider a set KR of critical capital  $k_r$  (not substitutable and non-zero):

$$KR = \{k_1, k_2, \dots, k_n\}$$

Let  $k_r'$  be the growth of each critical capital:

$$k_r' = k_{rt} - k_{r0}$$

$k_{r0}$  = capital  $r$  at initial time

$k_{rt}$  = capital  $r$  at  $t$  time

The generalized condition of sustainability is [Kestemont, 2010]:

$$(4) \quad \forall k_r \in KR, k_r' \geq 0$$

*Any critical capital must maintain or increase*

Any critical capital suffices to determine unsustainability. It is not necessary to find a weighting method (or a single unit) to determine unsustainability: each problem must be assessed with a relevant unit. Examples of global critical capitals or factors are climate change, ocean acidification, stratospheric ozone, the biogeochemical cycles of nitrogen and phosphorus, the overall use of fresh water, change of land use, biodiversity, fish stock, toxic concentrations, biocapacity, access to food, health and minimum life conditions, copper, nickel, lead, tin, energy return on energy investment [Rockström, 2009, Gately, 2007, Cleveland et al., 1984, Kesler, 1994, Wackernagel et Rees, 1996, Daly, 1973]. Stocks of minerals and fossil fuels should be stabilized as soon as possible since only a natural resource being both renewable and substitutable can be consumed in a sustainable manner [Hartwick, 1977, Hotelling, 1931, Martinet et Rotillon, 2007, Comolli, 2006]. Other critical capitals result from the combination of different phenomena, such as eutrophication which depends on the fixing of phosphorus and nitrogen from the atmosphere by industry and agriculture [Carpenter et al., 1998]. The various expressions of "weak total capital"  $k$ , of formula (1), like genuine savings or biocapacity have all the characteristics of critical capitals among others, which should also be maintained.

It appears that strong sustainability as defined here is a more general model than the weak sustainability since it allows to include conditions of weak sustainability, not vice versa.

An uncertainty remains about the determination of eligible "limits" of these critical assets. Low and high assumptions are usually necessary and involve a normative choice of risk that humanity is ready to run, in which an ethical factor may intervene [Rockström, 2009]. Therefore, even if science determines critical factors and probable limits, we say that the limits are *relatively objective*. Their distribution between actors and local targets or quota's is of course normative.

## 2.2. Mathematics for strong sustainability

Weighted or not weighted sums, products or ratios and related means mathematically imply possible substitution between the factors.

The arithmetic function has no unambiguous meaning for unmatched variables, such as temperatures expressed in different units, or temperatures and masses [see Ebert et Welsch, 2004]. This is enough to disqualify most of the sustainable development synthetic indices of

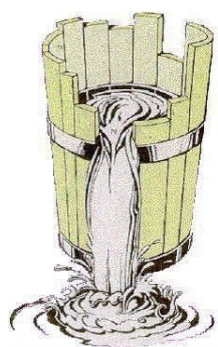
the literature, most of them using an arithmetic aggregation of incomparable phenomena [Singh et al., 2009]. How could we then "scientifically" aggregate incomparable factors? The only way to aggregate non comparable interval scales is a "dictatorial" ranking on one arbitrary variable, ignoring the other variables<sup>1</sup>.

Let us propose the following aggregation function:

$$(5) \quad \min (k_r') \geq 0 \Rightarrow \text{sustainable}$$

*Unsustainability is determined by the most threatened critical capital*

Formula (5) reflects unsustainability whatever the unit or weighting method used. It is sufficient that the result is less than zero to determine that there is unsustainability.



**Figure 1 :** The most critical capital limits the maximum capacity

Figure 1 illustrates the concept of "aggregated" capital according to the strong sustainability. If each plank is a critical capital, or a non-substitutable production factor ("limiting factor"), it is the shortest plank that determines the capacity of the bucket.

A sustainable development policy would "simply" consist of maximising the most critical factor<sup>2</sup>.

$$(6) \quad \max (\min (k_r'))$$

This principle provides a criterion for selecting the most relevant parameters for benchmarking or sustainability performances: other factors (the longest planks in figure 1) are simply not important and can be neglected unless they attain a "critical" limit at the studied scale (world or local).

Formula (5) only identifies the most critical factor in case of unsustainability. Nuances such as "more or less sustainable" or "degrees of sustainability" are necessarily normative [Kestemont, 2010]. It depends on the weights one might attribute to different non-substitutable critical factors (for example to choose between unsustainable biodiversity evolution and unsustainable environmental health for the people).

<sup>1</sup> Following the Arrow's theorem according to which it is impossible to develop an (not dictatorial) aggregate preference from ordinal individual preferences [Arrow, 1951].

<sup>2</sup> For a discussion on the maximin, see Arrow [Arrow, 1978]. For an application to individual critical capitals of "capabilities", see Sen [Sen, 1977].

For non comparable variables in scale ratio, ratios or geometric means are possible under certain conditions (positive values, non-negative weights)[Tsui et Weymark, 1997, Ebert et Welsch, 2004]. "Distances to target" types of indicators can have these properties, as well as "head counts" types of indicators like percentage of poor people, percentage of indicators exceeding a reference value for a given country, percentage of threatened species, etc.

Ratios are equivalent to a normative weighting scheme. For example, decoupling indicators or efficiency indicators of the type CO<sub>2</sub>/GDP or CO<sub>2</sub>/capita could be interpreted as giving more "rights" to each dollar or to each people to emit CO<sub>2</sub>, this choice being disputed between countries with higher population or higher GDP. The only unambiguous ratio is dividing a unit by a reference in the same (fully comparable) unit. For example a percentage of population having access to water, a GDP or TMR growth, or a recycling rate.

The notion of critical capital gives a way to negatively prioritize "less important" problems. Solved problems can be deleted from the headline indicator lists.

### 3. Responsibility

Shared responsibilities are a growing paradigm in environmental policy. Causes and effects of environmental pressures are not always situated at the same place and time and do not always involve a unique actor. In the perspective of environmental justice, the "polluter pays" principle has been used in order to address the issue of treating environmental pressure at its early original "decision". However, it is not evident to determine the original cause of pollution. Is it the producer or the customer, or both in their mutual interest at the expense of the common good?

Severe environmental policy in rich countries may result in displacing dirty industries to third countries paid in some way "to do the dirty job", still satisfying the same demand. When global threats are concerned (e.g. CO<sub>2</sub> emissions), this environmental leakage may underpin the chances of success of global environmental policies (e.g. the Kyoto protocol). A pragmatic approach may be to make consumers assume their responsibility (to pay) for the emissions "embedded" in the products they consume. These «embedded» emissions are illustrated by the notion of ecological rucksack associated to final products (figure 2).

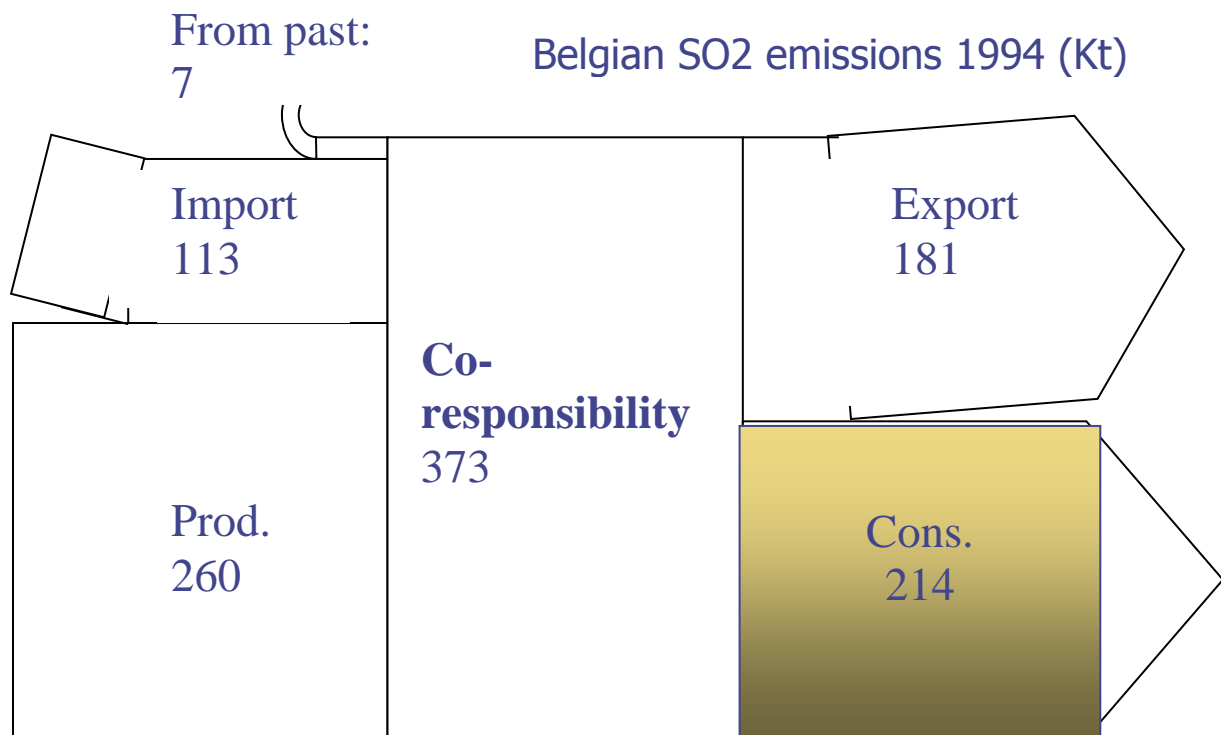


**Figure 2:** The ring of the bride with its shadow "embedded" environmental burden

Indicators are then needed to be able to evaluate the contribution of each "beneficiary" to the pollution, from the producer to the consumer including the trader all along the life cycle of the

product. Environmental accounting can trace the macroeconomic contribution to diverse environmental effects, from a producer (offer) to consumption (demand or "footprint") as illustrated in figure 3 for Belgian SO<sub>2</sub> emissions accounts.

The distribution of responsibilities and duties is a normative question that should be negotiated once the data are available. Without explicit negotiation, there is a risk of “tragedy of the commons”, each individual externalizing the ultimate environmental impacts of its decisions (production, trade or consumption) without global concern.



**Figure 3:** Potential action points for Belgium in global SO<sub>2</sub> emissions. The national emissions amounted to about 260 kt in 2004 and were the main target of environmental policy. Producers, government and households directly emitted SO<sub>2</sub> within the national borders but the policy did not consider embedded emissions in traded (or consumed) products [Kestemont, 2003].

#### 4. Equity

Sustainable development implies an intra- and intergenerational equity dimension [Gasparatos, El-Haram et Horner, 2008, Zaccaï, 2002]. Some minimum equity is not only an ethical question, but also a pragmatic one as argued by Sen and others. Even rich people have an economic interest in the wellbeing of their neighbours (being potential consumers or producers).

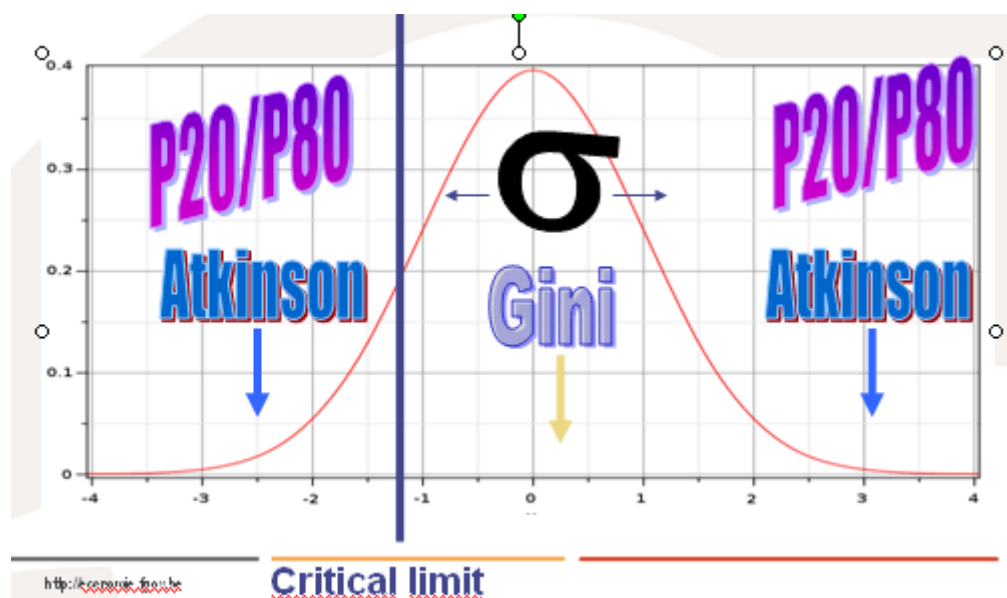
The problem of equity is not limited to shared or minimum revenues (absolute or relative poverty lines). Due to the multidimensional character of poverty and/or “limiting factors” [Atkinson, 1987, Alkire et Foster, 2009], redistribution concerns all dimensions presented above: distribution of all critical capital from producer to consumer perspectives.



There is not only one cake to be shared between people but several cakes, as illustrated in figure 4. However, specific methods may be needed to identify disparity targets (Figure 5), from the inequality coefficients (Gini, Atkinson, variance ...) to critical “poverty lines” for each of them (resource or environmental “poverty lines” or vital minimum) and percentage of population suffering from “environmental poverty” or limited access to basic critical capitals.

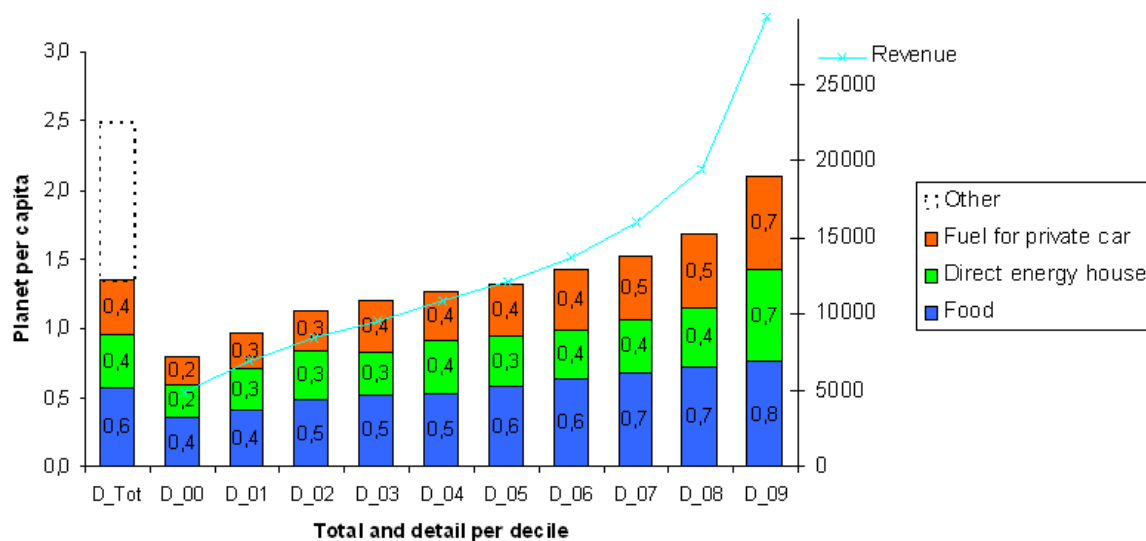


**Figure 4:** Equity = sharing the cakes



**Figure 5:** Methods are needed to indicate critical capital disparities

The relevance of environmental equity measurement can be illustrated with the example of the distribution of the ecological footprint per capita in Belgium. Despite a relatively low revenue disparity (Gini 2006 after transfer= 0.3) and a high mean ecological footprint per capita (the 4<sup>th</sup> larger in the world), there is still some domestic ecological footprint disparity for basic goods as illustrated in figure 6. The footprint disparity might be lower than the revenue disparity, but this has to be confirmed when the overall footprint distribution will be estimated.



**Figure 6:** Ecological footprint of food and final combustion per revenue deciles in Belgium 2006 (planet-equivalent per capita). About ½ of the total footprint is covered by these basic needs. Total revenue distribution is displayed for information. Source: Lepomme and Kestemont, 2012, communication to 18th Annual International Sustainable Development Research Conference, 24-26th June 2012 in Hull, UK.

## 5. Conclusion

I proposed three strong sustainability conditions and the related metrics: critical capitals, responsibility and equity considerations. Figure 7 summarizes the 3 sustainability conditions presented here, the metrics that could be used and finally the benchmarking indicator types that could be proposed. Distances to targets and number or percentages of threats (number of indicators or people beyond the critical limit) are relevant macro-indicators in this context.

OECD already pioneered indicator publications in line with the present criteria. One can mention the consumption based CO<sub>2</sub> emissions presented back to back with national emissions, and the “access to” type of indicators (percent population with access to water, water sanitation, percent population leaving in polluted areas etc).






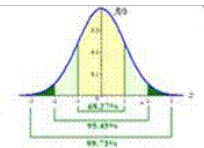
<u>Condition</u>	<u>Metrics</u>	<u>Benchmarking</u>
Limits 	MIN 	Distance to target Number of threats
Responsibility 		Distance to target Number of threats
Equity 		Disparity % threatened

Figure 7: summary

I redefine the weak sustainability as the reduction of complexity to a single dimension. There are therefore as many weak sustainability indicators as possible choices of this single dimension. Norms are unavoidable to determine implicit or explicit weighting schemes (including the choice of units in weak sustainability), the studied universe or responsibility attribution and the distribution of critical assets amongst present and future generations. Strong sustainability is characterized by the multiplicity of dimensions or critical capitals which, if exceeded one, suffice to determine the non-sustainability. The limits associated to critical capitals are relatively objectives. They are determined with some uncertainty by science, but a risk the society is ready to take has to be decided. Moreover, the distribution of the critical capitals between generations and associated uncertain risks are also subject to normative choice. However, one can imagine identifying relatively objective “poverty lines” (critical capitals at the level of individuals, called capabilities).

It appears that it is possible to identify in any calculation of sustainable development indicator, a relatively objective component of sustainability and a negotiable component of shared rights and responsibilities. This has practical utility for assessing the choice of metrics and clarifying the negotiation issues.

## References

- ABDALLAH, S., THOMPSON, S. et MARKS, N. (2008) "Estimating worldwide life satisfaction", *Ecological Economics*, **65**, **1**, 35-47.
- ALKIRE, S. et FOSTER, J. (2009) *Counting and Multidimensional Poverty Measurement*, Oxford Poverty and Human Development Initiative, Oxford, 44.
- ARROW, K. J. (1951) *Social Choice and Individual Values*, Wiley, Chapman & Hall, New York, London, 99.
- ARROW, K. J. (1978) "Extended Sympathy and the Possibility of Social Choice", *The American Economic Review*, **67**, **1**, 219-225.
- ATKINSON, A. B. (1987) "On the Measurement of Poverty", *Econometrica*, **55**, **4**, 749-764.

- BARBIER, E. B. (1989) *Economics, Natural Resource Scarcity and Development. Conventional and Alternative Views*, Earthscan, London.
- BARNETT, H. J. et MORSE, C. (1963) *Scarcity and Growth. The Economics of Natural Resource Availability*, Johns Hopkins University Press, Baltimore.
- BAUMGÄRTNER, S., BECKER, C., FARBER, M. et MANSTETTEN, R. (2006) "Relative and absolute scarcity of nature. Assessing the roles of economics and ecology for biodiversity conservation", *Ecological Economics*, **59**, **4**, 487-498.
- BLACKORBY, C. et DONALDSON, D. (1982) "Ratio-Scale and Translation-Scale Full Interpersonal Comparability without Domain Restrictions: Admissible Social-Evaluation Functions", *International Economic Review*, **23**, **2**, 249-268.
- CARPENTER, S. R., CARACO, N. F., CORRELL, D. L., HOWARTH, R. W., SHARPLEY, A. N. et SMITH, V. H. (1998) "Nonpoint Pollution of Surface Waters with Phosphorus and Nitrogen", *Ecological Applications*, **8**, **3**, 559-568.
- CLEVELAND, C. J., COSTANZA, R., HALL, C. A. S. et KAUFMANN, R. (1984) "Energy and the U.S. Economy: A Biophysical Perspective", *Science*, **225**, **4665**, 890-897.
- COMOLLI, P. (2006) "Sustainability and growth when manufactured capital and natural capital are not substitutable", *Ecological Economics*, **60**, **1**, 157-167.
- DALY, H. E. (1973) *Towards a Steady-State Economics*, W.H. Freeman, San Francisco, CA.
- DALY, H. E. (1977) *Steady-state economics*, Freeman, San Francisco.
- DALY, H. E. (1997a) "Georgescu-Roegen versus Solow/Stiglitz", *Ecological Economics*, **22**, **3**, 261-266.
- DALY, H. E. (1997b) "Reply to Solow/Stiglitz", *Ecological Economics*, **22**, 271-273.
- DIENER, E. (1984) "Subjective well-being", *Psychological Bulletin*, **95**, **3**, 542-575.
- EASTERLIN, R. A. (1995) "Will raising the incomes of all increase the happiness of all?" *Journal of Economic Behavior & Organization*, **27**, **1**, 35-47.
- EBERT, U. et WELSCH, H. (2004) "Meaningful environmental indices: a social choice approach", *Journal of Environmental Economics and Management*, **47**, **2**, 270-283.
- FLEURBAEY, M. (2008) "Beyond GDP: Is There Progress in the Measurement of Individual Well-Being and Social Welfare?" 48.
- GASPARATOS, A., EL-HARAM, M. et HORNER, M. (2008) "A critical review of reductionist approaches for assessing the progress towards sustainability", *Environmental Impact Assessment Review*, **28**, **4-5**, 286-311.
- GATELY, M. (2007) "The EROI of U.S. offshore energy extraction: A net energy analysis of the Gulf of Mexico", *Ecological Economics* Volume, **63**, **2-3**.
- GEORGESCU-ROEGEN, N. (1971) *The Entropy Law and the Economic Process*, Harvard University Press, Cambridge Mass.
- GOWDY, J. (2005) "Toward a new welfare economics for sustainability", *Ecological Economics*, **53**, **2**, 211-222.
- HARTWICK, J. (1977) "Intergenerational equity and the investing of rents from exhaustible resources", *American Economic Review*, **67**, **972**, 974.
- HEAL, G. (1998) *Valuing the Future: Economic Theory and Sustainability*, New Columbia University Press, York.
- HOTELLING, H. (1931) "The economics of exhaustible resources", *Journal of Political Economy*, **41**, **1**, 28.
- KESLER, S. E. (1994) *Mineral Resources, Economics and the Environment*, Macmillan Co, New York.
- KESTEMONT, B. (2003) "Critique des conditions de la durabilité: application aux indices de développement durable". , IGEAT-ULB, 214 pp." *Travail de fin d'études. DEA en gestion de l'environnement*, Travail de fin d'études, 214 pp.

- KESTEMONT, B. (2010) *Les indicateurs de développement durable. Fondements et applications. / Indicators of sustainable development. Fundamentals and applications*, PhD thesis, Université libre de Bruxelles, Bussels, 256.
- MARTINET, V. et ROTILLON, G. (2007) "Invariance in growth theory and sustainable development", *Journal of Economic Dynamics and Control*, **31, 8**, 2827-2846.
- MENTZAKIS, E. et MORO, M. (2008) "The poor, the rich and the happy: Exploring the link between income and subjective well-being", *The Journal of Socio-Economics*, **Article in Press, Corrected Proof**.
- NEUMAYER, E. (2003) *Weak Versus Strong Sustainability. Exploring the Limits of Two Opposing Paradigms*, Edward Elgar, Cheltenham, UK.
- PEARCE, D. W. et BARBIER, E. B. (2000) *Blueprint for a Sustainable Economy*, Earthscan, London.
- ROCKSTRÖM, J. (2009) "A safe operating space for humanity." *Nature*, **461, 7263**, 472-475.
- SEN, A. (1977) "On Weights and Measures: Informational Constraints in Social Welfare Analysis", *Econometrica*, **45, 7**, 1539-1572.
- SINGH, R. K., MURTY, H. R., GUPTA, S. K. et DIKSHIT, A. K. (2009) "An overview of sustainability assessment methodologies", *Ecological Indicators*, **9, 2**, 189-212.
- SOLOW, R. M. (1974) "The economics of resources and the resources of economics", *American Economic Review*, **64**.
- SOLOW, R. M. (1993) "An almost practical step towards sustainability", *Resources policy*, **19**, 162-172.
- SOLOW, R. M. (1997) "Reply: Georgescu-Roegen versus Solow/Stiglitz", *Ecological Economics*, **22, 3**, 267-268.
- STEVENSON, B. et WOLFERS, J. (2008) *Economic Growth and Subjective Well-Being: Reassessing the Easterlin Paradox*, Institute for the Study of Labor, Bonn, 80.
- STIGLITZ, J. E. (1997) "Georgescu-Roegen versus Solow/Stiglitz - reply", *Ecol.Econ.*, **22**, 269-270.
- TSUI, K.-Y. et WEYMARK, J. A. (1997) "Social Welfare Orderings for Ratio-Scale Measurable Utilities", *Economic Theory*, **10, 2**, 241-256.
- UNDERWOOD, D. A. et KING, P. G. (1989) "On the ideological foundations of environmental policy", *Ecological Economics*, **1**, 315-334.
- UNECE (2009) *Measuring sustainable development*, United Nations Economic Commission for Europe, new York and Geneva, 102.
- VAN DEN BERGH, J. C. J. M. (2007) *Abolishing GDP*, Free University Amsterdam, Amsterdam, 24.
- VEENHOVEN, R. (1991) "Is happiness relative?" *Social Indicators Research*, **24, 1**, 1-34.
- WACKERNAGEL, M. et REES, W. E. (1996) *Our Ecological footprint: Reducing Human Impact on the earth.*, New Society Publishers, Philadelphia.
- WORLD BANK (2006) *Where is the Wealth of Nations*, Washington D.C., 188.
- ZACCAÏ, E. (2002) *Le développement durable. Constitution et dynamique d'un projet*, P.I.E. - Peter Lang, Berne-Bruxelles, 352.



# Developing a multidisciplinary sustainability understanding for corporate strategic management

- **ISDR Conference** June 25, 2012 – Hull University
  - Friederike Neugebauer
- Queen's University Management School, Belfast & Robert Bosch GmbH, Stuttgart

## Contents

### 1) Introduction

- Idea of the paper
- Methodology

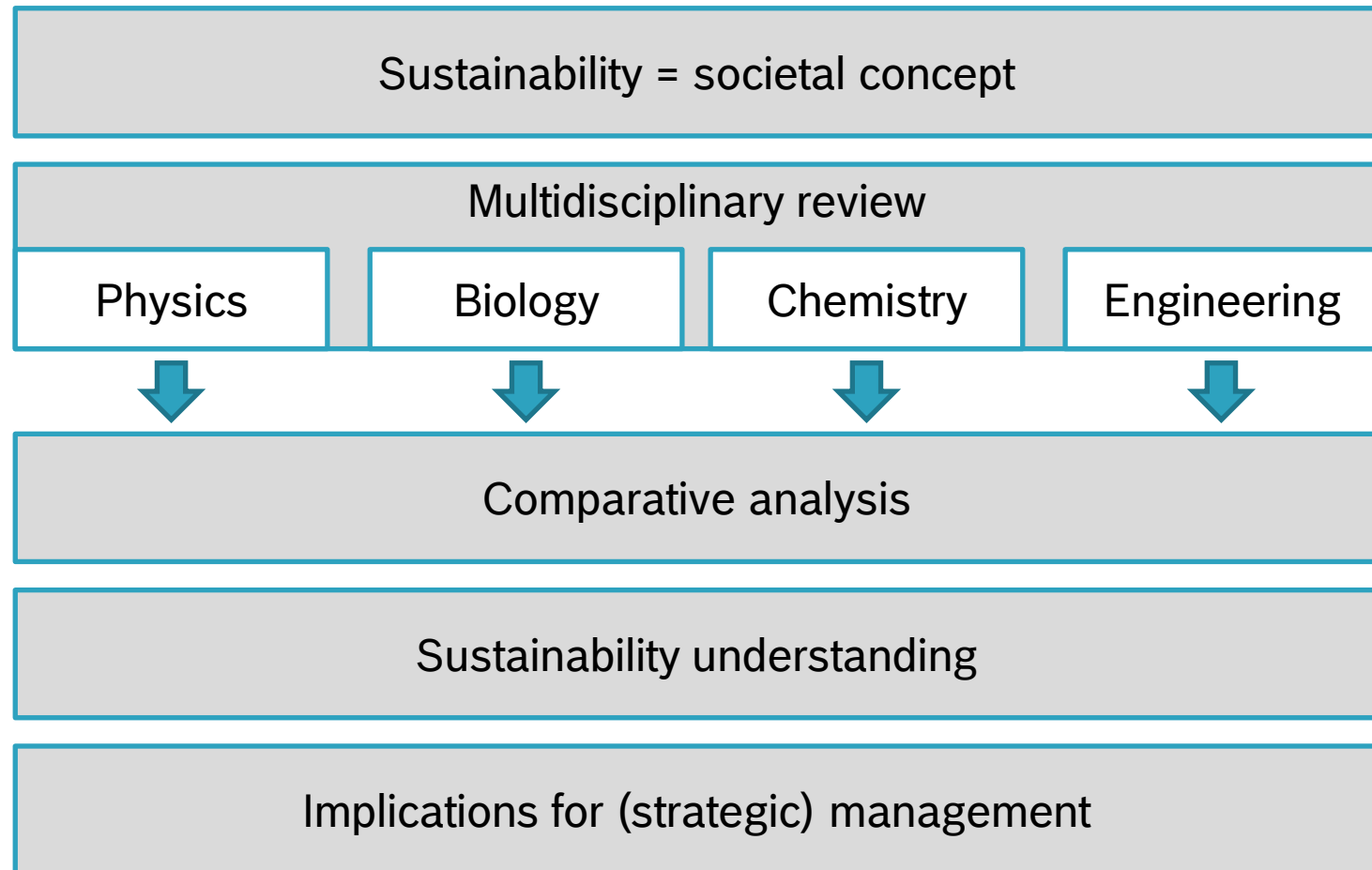
### 2) Main part

- Findings: Sustainability from the perspectives of four natural sciences
- Discussion
- Resulting understanding of corporate sustainability
- Implications for management

### 3) Outlook

### 4) Discussion

## Idea of the paper





## Methodology

Review of the sustainability understandings in ...

- Physics
- Biology
- Chemistry
- Engineering

Categories emerged during review

- Value orientation
- Sustainability approach
  - Systems thinking?
  - Acceptance of finite resources?
- Policy recommendations
- Sustainability metrics
- Disciplinary intersections

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### 4) Discussion

# Findings

Research streams / Categories	Physical research (thermodynamics)	Biological research (ecosystem biology)	Chemical research (Green Chemistry)	Engineering research (Ecological Engineering)
<b>Underlying value orientation</b>	Anthropocentric	Anthropocentric and ecocentric	Anthropocentric	Anthropocentric and ecocentric
<b>Sustainability approach</b>	Spaceship earth is a materially closed system; thus, cannot steadily use resources faster than they grow back	A sustainable ecosystem remains intact over a long period of time	Mostly borrowed from Brundtland Report; focus on eco-efficiency and on atom/molecular level	Symbiotic balance between industrial systems and ecosystems
<b>Systems thinking</b>	x	x		x
<b>Acceptance of finite resources</b>	x		x	x
<b>Target groups of policy recommendations</b>	Society at large, economics researchers	Conservation policy makers	Industry, chemistry researchers	Industry, engineering researchers
<b>Sustainability metrics</b>	Exergy analysis	Biodiversity, resilience, vulnerability	E-factor	fuzzy logic
<b>Discipline intersections</b>	Economics, ecological engineering	Economic/financial theory (ecosystem services valuation)	Industrial ecology, parallels with Ecological Modernization	Biology/ecology, industrial ecology

# Findings (value orientation)

Research streams / Categories	Physics	Biology	Chemistry	Engineering
Underlying value orientation	Anthropocentric	Anthropocentric and ecocentric	Anthropocentric	Anthropocentric and ecocentric
Selection of sources	<i>Gutowski et al., 2009; Hammond, 2004; Krysiak, 2006; Ruth, 2005.</i>	<i>Anthropocentric: Folke et al., 2002; Paoletti, 1999. Ecocentric: Hooper et al., 2005; Robinson, 1993; Myers, 2002; Scheffer et al., 2001.</i>	<i>Horváth &amp; Anastas, 2007; Kirchhoff, 2005; Venselaar, 2003; Winterton, 2003.</i>	<i>Bakshi &amp; Fiksel, 2003; Farrell, 1996; Mitsch &amp; Jørgensen, 2004; Odum, 1996; Odum &amp; Odum, 2003.</i>

# Findings (sustainability approach)

Research streams / Categories	Physics	Biology	Chemistry	Engineering
Sustainability approach	Spaceship earth is a materially closed system; thus, cannot steadily use resources faster than they grow back	A sustainable ecosystem remains intact over a long period of time	Mostly borrowed from Brundtland Report; focus on eco-efficiency and on atom/molecular level	Symbiotic balance between industrial systems and ecosystems
Selection of sources	<i>Boulding, 1993; Daly, 1973; Gutowski et al., 2009; Kåberger &amp; Månsson, 2001.</i>	<i>Ho &amp; Ulanowicz, 2005; Hooper et al., 2005; Kay et al., 1999; Paoletti, 1999.</i>	<i>Horváth &amp; Anastas, 2007; Kirchhoff, 2005; Tundo et al., 2007; Venselaar, 2003; Winterton, 2003.</i>	<i>Odum &amp; Odum 2003; Mitsch &amp; Jørgensen, 2004.</i>

# Findings (systems and limitations)

Research streams / Categories	Physics	Biology	Chemistry	Engineering
Systems thinking	x	x		x
Acceptance of finite resources	x		x	x
<i>Selection of sources</i>	<i>Ayres, 1998; Boulding, 1993; Daly, 1973, 1999; Krysiak, 2006; Rifkin, 1980; Ruth, 2005.</i>	<i>Fraser et al., 2005; Ho &amp; Ulanowicz, 2005; Hooper et al., 2005; Kay et al., 1999; Perrings, 2006; Scheffer et al., 2001; Waltner-Toews &amp; Kay, 2005.</i>	<i>Tundo et al., 2000; Vanselaar, 2003.</i>	<i>Bakshi &amp; Fiksel, 2003; Glavic &amp; Lukman, 2007; Gosselin, 2008; Mitsch &amp; Jørgensen, 2003; Odum, 1996; Urban et al., 2010.</i>

# Findings (policy recommendations)

Research streams / Categories	Physics	Biology	Chemistry	Engineering
Target groups of policy recommendations	Society at large, economics researchers	Conservation policy makers	Industry, chemistry researchers	Industry, engineering researchers
Selection of sources	<i>Ayres, 1998; Daly, 1973, 1993, 1999; Kåberger &amp; Månsson, 2001; Krysiak, 2006; Söllner, 1997.</i>	<i>Folke et al., 2002; Fraser et al., 2005; McDaniel &amp; Gowdy, 1998; Myers, 2002; Perrings, 2006; Scheffer et al., 2001.</i>	<i>Collins, 2001; Horváth &amp; Anastas 2007; Kirchhoff; 2005; Manley et al., 2008; Venselaar, 2003.</i>	<i>Hasna, 2010; Odum &amp; Odum, 2003; Selinger, 2011; Thompson et al., 2011.</i>

# Findings (sustainability metrics)

Research streams / Categories	Physics	Biology	Chemistry	Engineering
Sustainability metrics	Exergy analysis	Biodiversity, resilience, vulnerability; bioindicators	E-factor	Fuzzy logic approach
Selection of sources	Ayres, 1998; Cornelissen, 1997; Georgescu-Roegen, 1986; Dincer, 2007; Glucina & Mayumi, 2010; Kåberger & Månsson, 2001; Rifkin, 1980; Ruth, 2005.	Faith et al., 2010; Figge, 2004; Fraser et al., 2005; van den Bergh et al., 2000; Perrings, 2006; Paoletti, 1999.	Centi & Perathoner, 2003; Manley et al., 2008; Sheldon, 2007; Tundo et al., 2000.	Cornelissen et al., 2001; Kouloumpis et al., 2008; Phillis et al., 2010; Vinodh et al., 2011.



# Findings (discipline intersections)

Research streams / Categories	Physics	Biology	Chemistry	Engineering
Discipline intersections	Economics, ecological engineering	Economic/financial theory (ecosystem services valuation)	Industrial ecology, parallels with Ecological Modernization	Biology/ecology, industrial ecology
Selection of sources	Ayres, 1998; Daly, 1973, 1999; Gowdy & Mesner, 1998; Gutowski et al., 2009; Hammond, 2004; Kåberger & Månsson, 2001; Krysiak, 2006.	Atkinson & Mourato, 2008; Farber et al., 2002; Figge, 2004; de Groot et al., 2002; Nielsen, 2007.	Centi & Perathoner, 2003; Horton, 1999; Horváth & Anastas, 2007; Kirchhoff, 2005; Warner et al., 2004.	Clark, 2002; Selinger, 2011; Tilley, 2003; Urban et al., 2010.

## Discussion

### Common ground

- Systems thinking and recognition of finite resources is derived from natural laws → core of sustainability understandings
- Humanities/ethics are drawn upon
  - All refer to WCED (1987) but don't rely equally on it for definition.
- Those streams close to industry (Green Chemistry, Ecological Engineering) overlap with Industrial Ecology

### Differences

- Target groups of policy recommendations vary
- Metrics are discipline-specific
- Different levels of maturity (and self-reflection)

# Resulting sustainability understanding

It is striking that humanities make their way into a strictly natural science review...

Sustainability is understood as

- (1) operating within the **global system boundaries** and deducing sustainability goals from the goal of societal sustainability,
- (2) and adopting a far-sighted view in order to serve both **current and future generations**.

# Implications for management

- 1) Enables a long-term holistic view
- 2) Valuable starting point for strategic management to deduce goals and develop strategy
- 3) Might even influence emergent strategy making if corporate culture is changed

## Contents

### 1) Introduction

- Idea of the paper
- Methodology

### 2) Main part

- Findings: Sustainability from the perspectives of four natural sciences
- Discussion
- Resulting understanding of corporate sustainability
- Implications for management

### 3) Outlook

### 4) Discussion

## Outlook

...but how can this sustainability understanding be put into practice?

What if it cannot simply be implemented and enforced at a company?

Then how do sustainability strategies emerge?



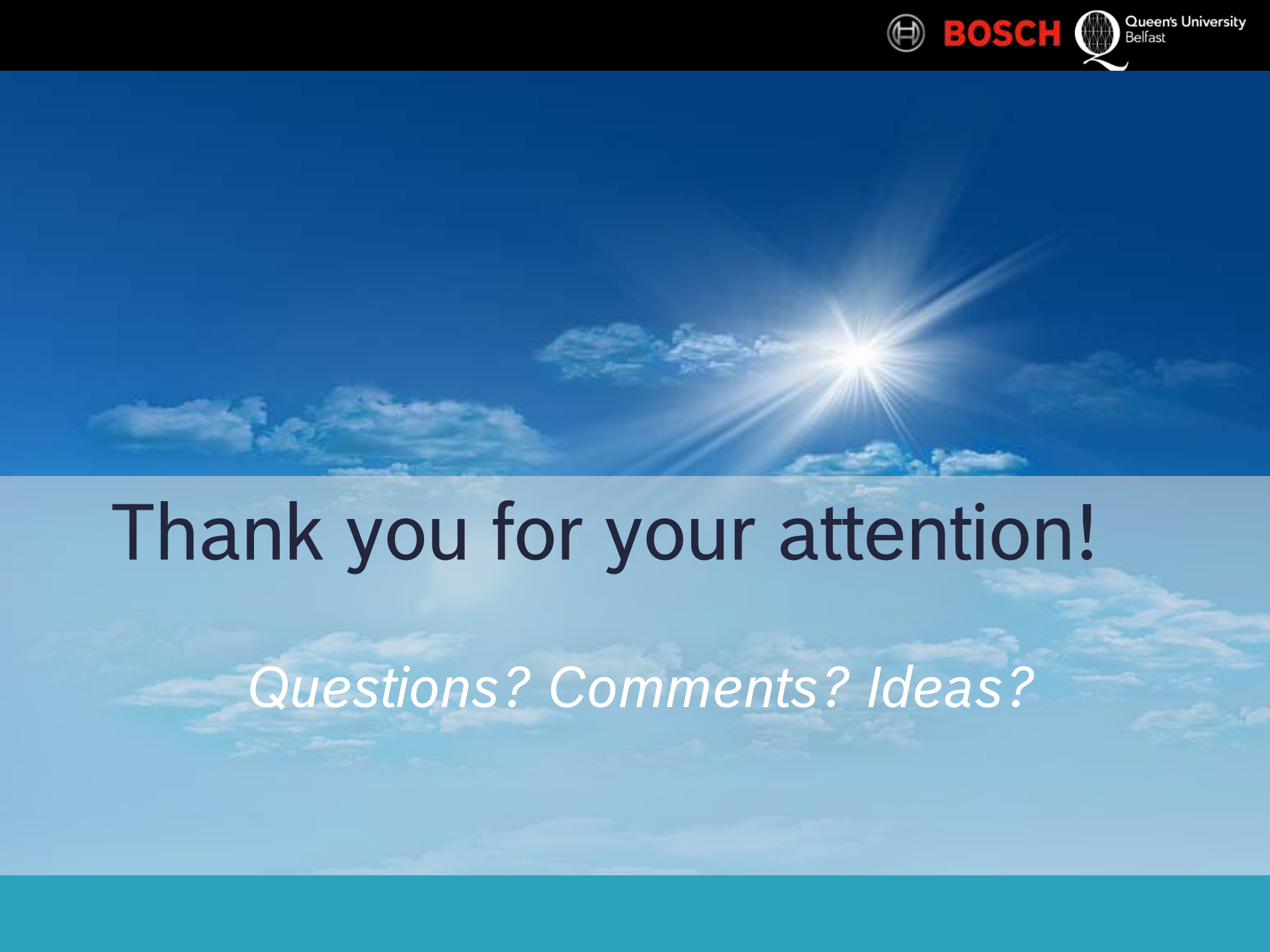
Further research



**BOSCH**



Queen's University  
Belfast

A background image of a bright sun shining through a blue sky with scattered white clouds. The sun is positioned in the upper right quadrant, creating a lens flare effect. The sky transitions from a deep blue at the top to a lighter blue near the horizon.

# Thank you for your attention!

*Questions? Comments? Ideas?*



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Belfast

A background image of a bright sun shining through a blue sky with scattered white clouds. The sun is positioned in the upper right quadrant, creating a lens flare effect. The sky transitions from a deep blue at the top to a lighter blue near the horizon.

# Back up



## **Proceedings of the 18<sup>th</sup> Annual International Sustainable Development Research Conference, University of Hull, Hull, UK, 24 – 26 June 2012; Track 2b**

### **Quantifying the Sustainability of Human–Environmental Networks: Seeking a Balance Between Efficiency and Resilience**

**Ali Kharrazi and Yarime Masaru**

*Graduate Program in Sustainability Science, Graduate School of Frontier Sciences, University of Tokyo*

The importance of sustainability continues to increase in this age as a new paradigm on which to base future policies upon. However, a universally accepted definition for sustainability has been arguably very difficult to achieve as the terminology remains highly subjective and open to different interpretations. In this light, efforts towards minimizing the influence of subjective arguments in the determination of an indicator for sustainability make it possible to create common grounds to compare alternative policies and to include sustainability as an objective for various human environmental systems. Specifically, the lack of objectivity towards defining sustainability prevents the discussion, legislation, and implementation of evidence-based policy making where the economic mechanisms dominating our societies are left unaffected and little change is brought about. This is not to condone the view that a subjective or ecocentric perspective will ultimately fail but echoing the writings of Herman Daly (1996) the most valuable incentive for change in our societies toward a sustainable future is achieved from the synergy of the ecocentric and anthropocentric world views; where economic mechanisms are readjusted to assume and reflect the challenges of sustainability. In an attempt to minimize the subjective arguments surrounding sustainability, researchers have recently begun to discuss ways of quantifying sustainability and incorporating the related costs of ecological risks in economic decision making.

Various attempts have been made in constructing conceptual tools for quantifying sustainability, the earliest of which have emerged from the field of ecology use thermodynamic principles. Chief among these early attempts has been emergy analysis which has in turn inspired the development of other conceptual tools such as exergy analysis, eco-footprint analysis, and ecological network analysis for the quantification of sustainability. The methods related to emergy, exergy, and eco-footprint analysis approach the quantification of sustainability from an accounting perspective and have been extensively discussed and employed in the literature. In the case of the relatively less researched ecological network analysis, the quantification of sustainability is approached from a network perspective where special emphasis is given to the resilience of the system when faced with disturbances and where the sustainability of the system is evaluated as a balance

between efficiency and resiliency. This paper is a critical review of each analytical approach in the quantification of sustainability. Furthermore, this paper discusses recent findings in employing the ecological network approach in analyzing the sustainability of various networks such as commodity trade, foreign direct investment, and virtual water trade. These findings suggest that while previous attempts at the quantification of sustainability have succeeded in highlighting the need of *reducing un-sustainability* from an accounting perspective, it is necessary to consider the evaluation of the resiliency of the system under study for *increasing sustainability* from a network perspective. Finally this paper will discuss the importance of a data-intensive approach for sustainability science research and the possibility of applying sustainability quantification methods to other human and natural coupled systems.

**Keywords:** *sustainability quantification, resilience, efficiency, human natural coupled systems, data-intensive research*

## **Bibliography:**

Fiksel J. 2006. Sustainability and resilience: toward a systems approach. Sustainability: Science, Practice, & Policy 2(2):14-21

Goerner, S.J., Lietaer, B. and Ulanowicz, R.E. 2009. Quantifying economic sustainability: Implications for free-enterprise theory, policy and practice. Ecological Economics 69:76-81.

Herman E. Daly. Beyond Growth: The Economics of Sustainable Development. Beacon Press, 1996.

May, RM, Levin, SA & Sugihara, G. Ecology for Bankers. Nature, 451, 893-895 (2008)

Ulanowicz, R.E., Goerner, S.J., Lietaer, B. and Gomez, R. 2009. Quantifying sustainability: Resilience, efficiency and the return of information theory. Ecological Complexity 6:27-36.

Proceedings of the 18<sup>th</sup> Annual International Sustainable Development Research Conference, University of Hull, Hull, UK, 24 – 26 June 2012; Track 2c

# A decomposition of the effect of Renewable Energy Sources regulation on CO<sub>2</sub> emissions in the EU-15

Thomas Alexopoulos, Dimitrios Thomakos and Dionisia Tzavara

**Abstract** — A lot of emphasis is placed by the EU on developing strategies to combat climate change. To this direction the EU recognizes that climate change and energy policies need to be integrated and has developed the EU climate change and energy package to achieve emission and renewable energy development targets. To increase the share of renewables in the energy mix, which is considered key to achieving emission targets, the European Commission promotes a common framework described in relevant directives, coordination of efforts across countries, and the use of a number of instruments, measures. In this paper we are interested in the effectiveness to reduce emissions of different sources of regulation to promote renewable energy sources (RES) and the directive 2001/77/EC, the first directive for the promotion of RES. Building upon our previous work we decompose the effect on CO<sub>2</sub> emissions of regulation to promote the use of RES and we differentiate between the pre- and post-directive era. We find that, after the decomposition of RES regulation to feed-in tariffs and all other measures,

all measures have a positive effect on reducing CO<sub>2</sub> emissions with feed-in tariff measures exhibiting the greatest impact compared to the aggregate of all other measures. We also find that the implementation of the directive has a positive effect on the reduction of CO<sub>2</sub> emissions.

**Keywords** — CO<sub>2</sub> emissions, fossil fuels, final energy consumption, regulation, renewable energy, feed-in tariffs, EU directive.

**Track** — 2c Climate change adaptation

## I. INTRODUCTION

There is a lot of emphasis placed by the EU on developing strategies to combat climate change. To this direction the EU recognizes that climate change and energy policies need to be integrated and has developed the EU climate change and energy package and adopted regulation to achieve its ‘20-20-20’ targets. The ‘20-20-20’ targets require that by 2020 (i) GHG emissions are reduced by 20% (compared to 1990 levels), (ii) the share of renewable energy is increased to 20%, and (iii) energy efficiency is increased by 20% (European Council, 2009).

Increasing the share of Renewable Energy Sources (RES) in the energy mix across European countries is considered a key factor in the direction of reducing GHG emissions, complying with requirements of the Kyoto protocol, and

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contributing to global coordinated efforts to fight climate change. An increased share of renewables is anticipated to work together with measures to promote energy preservation and efficient energy use to achieve the target of arriving at a low carbon economy (Commission of the European Communities, 2009, p. 1).

The European Commission recognizes the importance of the regulatory framework to promote RES and to achieve emission targets, and promotes the use of a number of policy measures and instruments to increase the share of renewable sources in the energy mix. Those instruments should work towards “reducing the cost of energy, increasing the price at which it can be sold, or increasing, by means of a renewable energy obligation or otherwise, the volume of such energy purchased”. Such instruments are among others “investment aid, tax exemptions or reductions, tax refunds, renewable energy obligation support schemes including those using green certificates, and direct price support schemes including feed-in-tariffs and premium payments” (Commission of the European Communities, 2009, p. 27).

Also, the Commission acknowledges the importance of member states’ freedom to choose the instruments and mechanisms to promote the use of RES, and at the same time, the need to coordinate efforts across member states to achieve the common targets. This coordination of efforts starts with the introduction of the 2001/77/EC directive, the first directive introduced for the promotion of the use of RES in the production of energy, and is supported by consecutive directives. The 2009/28/EC Directive on the promotion of the use of energy from renewable sources requires member states to submit their National Renewable Energy Action Plans which will outline the member states’ strategy to achieve the common targets, including the instruments and measures that the country will adopt to support and develop RES technology and investment (Commission of the European Communities, 2009; Jager-Waldal *et al.*, 2011). There are a number of measures and instruments that have been used across European countries to promote the use of energy from

renewable sources. According to the International Feed-in Cooperation (2010, p. 1), feed-in tariffs are the most widely used instrument among EU member states. Feed-in-tariffs are used either as a primary mechanism, or as a supportive mechanism, in combination with other mechanisms and only four member states do not use them at all as part of their policy to promote RES (International Feed-in Cooperation, 2010).

Global CO<sub>2</sub> emissions have been growing since 2000 (The World Bank, 2007) and are expected to continue growing (IEA, 2011). Also, as Europe’s economy is picking up, emissions are picking up as well (EurActiv, 2011). To be able to meet the ‘20-20-20’ objective relative to CO<sub>2</sub> emissions, it is important to understand what is driving those emissions. And while a number of factors have been considered relative to this question, we believe that the effect of regulation promoting RES has been overlooked.

We build upon previous work (Alexopoulos, Thomakos & Tzavara, 2012) and look at the effect that RES regulation has on the evolution of CO<sub>2</sub> emissions of EU-15 countries. Given the popularity of feed-in tariffs, we decompose RES regulation to feed-in tariffs and all other measures. All other measures include investment subsidies, quota obligations and green certificates, fiscal measures and bidding systems. Besides the popularity of feed-in tariffs, we choose to decompose between feed-in tariffs and all other measures for practical reasons, since there were not an acceptable number of observations for analysing each RES promoting variable separately. Also, given the emphasis placed on a common framework for the promotion of RES, we look at the effect of the imposition of the first directive to promote RES in the EU (the 2001/77/EC directive) on CO<sub>2</sub> emissions. We ask whether there is relationship between different types of RES regulation and CO<sub>2</sub> emissions, assess the efficiency and effectiveness of the regulation on reducing CO<sub>2</sub> emissions and focus in particular on the effectiveness of feed-in-tariffs as well as the common regulatory framework in achieving common emission targets.

We find that both feed-in tariffs regulation as well as the aggregate of all other measures are affecting positively the reduction of CO<sub>2</sub> emissions. Moreover it appears that feed-in tariffs are more effective than the aggregate of all the other measures in reducing emissions. We also find that the imposition of the common framework directive 2001/77/EC has a positive effect of reducing CO<sub>2</sub> emissions. In both cases, the efficacy of the instrument is dependent on the energy mix.

## II. LITERATURE REVIEW

The literature looking at factors affecting CO<sub>2</sub> emissions is quite extensive. Earlier literature starts from looking at the link between economic development and CO<sub>2</sub>. In this literature the well-known Environmental Kuznets Curve (EKC) hypothesis is prevalent. According to the hypothesis, emissions initially increase with output and then decrease as output increases, so that the relationship between the two takes the form of an inverted U-curve. But the EKC hypothesis is not always confirmed in the literature, so the idea that higher economic development will put downward pressure to emissions is not a universal finding. There is a number of studies looking to confirm or reject the EKC hypothesis – see for example, Stern (2004), Dinda (2004), Dinda and Coondoo (2006), Coondoo and Dinda (2002), Managi and Jena (2008), Tamazian and Rao (2010), Jaunky (2011), Zhang (2011).

Energy consumption is a driver of economic development and at the same time economic development is key to more efficient energy consumption patterns (Wolde-Rufael, 2006; Narayan and Singh, 2007; Narayan, Narayan and Prasad, 2008; Ozturk, Alsan and Kalyoncu, 2010; Belloumi, 2008; Mehrara, 2007; Freitas and Kaneko, 2011). Given the conformed relationship between energy consumption and economic development and the fact that economic development is a driver of CO<sub>2</sub> emissions, more recent literature confirms that there is a link between output, energy consumption and CO<sub>2</sub> emissions (Liaskas *et al.*, 2000; Ang, 2007; Ang, 2008; Apergis and Payne, 2009; Halicioglu, 2009;

Soytas and Sari, 2009; Marrero, 2010; Pao and Tsai 2010). The literature reveals that the form of the relationship between CO<sub>2</sub> emissions, energy consumption and output as well as the direction of causality depends on a number of factors, such as for example, estimation methods, variables included in empirical models, the spread of data, geographical focus.

This later literature also looks at including other factors to the analysis of what drives CO<sub>2</sub> emissions. So for example, Halicioglu (2009) looks at the impact of foreign trade on emissions, and finds that there is an effect of foreign trade on emissions, but this is of smaller magnitude compared to output and energy consumption. Liaskas *et al.* (2000) include structural change in their analysis. Structural change refers to the composition of the industrial sector in this study, and the authors find that the effect of the restructuring is ambiguous and “a shift towards less energy-intensive sectors” (p. 393) does not necessarily translate to a reduction in CO<sub>2</sub> emissions. Liaskas *et al.* (2000) also include a decomposition of the energy mix in their analysis and confirm that the energy mix affects the evolution of CO<sub>2</sub> emissions, a result also confirmed by Marrero (2010), who also considers the effect of the energy mix on emissions. Soytaş and Sari (2009) look at the link between CO<sub>2</sub> emissions, output and energy consumption, “controlling for gross fixed capital investment and labor” (p. 1667) in order to assess energy and environmental concerns in conjunction with growth concerns.

To best of our knowledge, the only study which looks at the effect of RES regulation on CO<sub>2</sub> emissions is our previous work ATT (2012). In that study the authors use data on emissions, the fossil fuel mix used for energy production and the final energy consumption mix and construct a new variable to account for national regulation to promote RES in these countries. The effect of RES regulation is captured by a binary dummy which captures the introduction of new measures in EU-15 countries and which accounts for all possible RES regulation measures. The authors find that RES regulation does have a negative and significant

effect on emissions and that this effect depends on the composition of the fuel mix. Also, the introduction of RES regulation seems to introduce some evidence of convergence on the composition of the fuel mix among the EU-15 and also some evidence of divergence in terms of how energy is used across EU-15.

Also, to our knowledge, while there is literature focusing on the mix of policies in relation to promoting penetration of RES in Europe (see for example Meyer, 2003; Haas *et al.*, 2004; Rowlands, 2005; Held, Ragwitz and Haas, 2006; Ringel, 2006; Jacobsson *et al.*, 2009; Jager\_Waldau *et al.*, 2011), these studies do not look at RES policies relative to achieving emission targets. Our current study builds upon our earlier study and aims to (i) decompose the effect of RES regulation into the feed-in-tariff effect and an all other measures effect, and (ii) look at the effect of a common policy to promote and support the use of RES for the production of energy across the EU-15 of CO<sub>2</sub> emissions. With this we aim to shed more light to earlier findings about the effect of RES regulation on CO<sub>2</sub> emissions and to inform the debate about instruments and measures used to promote the use of RES, maintaining the focus on how the mix of policy is going to help in the direction of reducing CO<sub>2</sub> emissions.

### III. DATA

In the analysis that follows we use a large part of the data from our earlier work Alexopoulos, Thomakos & Tzavara (2012) and we augment it with three new variables on regulation. Specifically, we have panel data on CO<sub>2</sub> emissions, the fossil fuel mix used for energy production, and the final energy consumption mix for the EU-15 countries and over the years 1980-2009 or 1990-2009, the latter when the final energy consumption is included. In the current analysis we use three new variables on regulation pertaining to RES promotion. These variables are constructed from individual country sources and correspond to specific regulatory measures – this is in contrast to our earlier analysis where an aggregate regulation variable was used. In this way we can examine in greater detail the efficacy of different policy

instruments on emissions. We discuss further these three new variables below.

The data of fossil fuel consumption mix and the total CO<sub>2</sub> emissions for the period 1980-2009, are available from the U.S. Energy Information Administration (EIA, 2011). The final energy consumption data are available from Eurostat (2011). For our RES regulation variables we conducted a systematic search so as to recognize all the possible legislative actions for the promotion of renewables. Data were derived from the German Federal Ministry for the Environment, Nature Conservation and Nuclear safety (2011) and from the Energy Research Centre of the Netherlands (2011). We categorized RES regulation into two categories. The first category includes feed-in-tariffs (RESRFIT). The term feed-in tariff is used both for regulated, minimum guaranteed prices per unit of produced electricity to be paid to the producer, as well as for premiums in addition to market electricity prices. The second category (RESROTH) includes all other kinds of promotional measures, such as investment subsidies which help to overcome the barrier of high initial investment, fiscal measures like rebates on energy taxes, lower VAT rates, tax exemption for green funds etc, quota obligations that impose a minimum electricity production or consumption from RES and the bidding systems. Finally we include a third variable (DIRDUM) that consolidates the EU 2001/77/EC directive, the first European directive for the promotion of RES, introducing a common framework for the promotion of RES.

For the purposes of this paper we put our regulation variables into binary form and we denote each one by a dummy  $D_{it}$ , which takes the value of 1 when a RES-promoting measure, of the first or the second or the third kind, becomes and stays active at year  $t$  in country  $i$ , and zero otherwise. Based on the implementation of RES regulation this dummy effectively acts as a structurally-defined sample-splitting device (before & after regulation) and we can thus compare the efficacy of the two aggregates, RESRFIT and RESROTH, as well as the common framework variable DIRDUM.

Our other variables are as follows. We use  $CO2_{it}$  to denote CO<sub>2</sub> emissions, and  $PC_{it}$ ,  $CC_{it}$ ,  $NGC_{it}$  and  $TFC_{it}$  to denote fossil fuel consumption per major category, i.e. petroleum consumption, coal consumption and natural gas consumption and their aggregate. Finally, we use  $TEC_{it}$  to denote the aggregate of the total final energy consumption from all major categories (households, industry, transport, services and other). For all the above variables (except the RES dummies) we take natural logarithms and their differences (growth rates), the latter being denoted with the letter  $\Delta$  in front of each variable.

Figure 1, reproduced from our earlier work Alexopoulos, Thomakos & Tzavara (2012, p. 3), shows the differences in the evolution of the emissions across countries, i.e. it contains the plots of the (natural) levels of  $CO2_{it}$  for all  $i$ . There is an important observation which we can make from Figure 1, which is that there is country heterogeneity present to our data, which motivates the use of our empirical methodology.

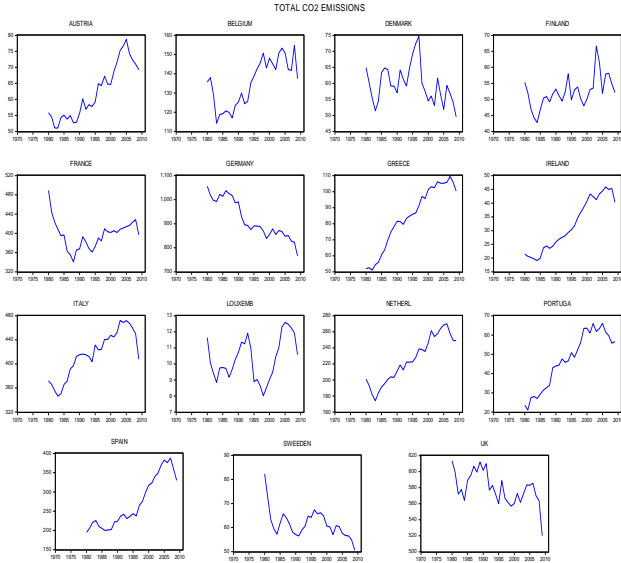


Fig. 1. Evolution of CO<sub>2</sub> emissions per country

Table I presents some summary statistics, to give us a preliminary understanding on the cross country differences and the effects of the use of RES regulation as an aggregate, as well as in the form of

feed-in tariffs, all other measures and the common framework directive. In Table I, we have the country averages for the growth rates of the variables we use in our analysis. At the end of the table we present the results of three types of statistics: an  $F$ -test for the hypothesis of equal growth rates ( $F$ -test all) and a re-application of the same test using data before and after the implementation of the RES regulation in each country (i.e. using the  $D_{it}$  variable of each country to do the sample-splitting). The first part of the tests is from our earlier work and is included for comparison purposes between the total aggregate RES regulation measure and the three particular aggregates that we use in this paper.

TABLE I  
Mean Growth Rates per Country

COUNTRY	$\Delta CO2$	$\Delta PC$	$\Delta CC$	$\Delta NGC$	$\Delta TFC$	$\Delta TEC$
AU	0,74%	0,53%	-1,64%	1,78%	0,31%	1,66%
BE	0,04%	0,53%	-4,33%	1,70%	-0,21%	0,45%
DN	-0,93%	-1,91%	-1,24%	16,46%	-0,93%	0,58%
FI	-0,20%	-1,01%	-0,67%	5,36%	-0,36%	0,59%
FR	-0,72%	-0,73%	-4,16%	1,96%	-0,83%	0,75%
DE	-1,11%	-0,81%	-2,63%	0,76%	-1,72%	-0,35%
EL	2,27%	1,54%	3,52%	14,91%	3,02%	1,95%
IE	2,17%	2,00%	2,00%	5,90%	2,08%	2,58%
IT	0,32%	-0,81%	0,26%	3,59%	0,47%	0,62%
LUX	-0,33%	3,08%	-10,94%	2,78%	-0,35%	1,10%
NL	0,74%	1,33%	2,39%	0,49%	1,11%	1,08%
PT	3,02%	1,94%	6,53%	32,34%	3,29%	2,36%
ES	1,81%	1,36%	-1,30%	10,56%	1,37%	2,36%
SE	-1,68%	-1,55%	-1,44%	10,90%	-1,38%	0,12%
UK	-0,57%	-0,12%	-3,13%	2,08%	-0,66%	0,07%
<b>RESRALL</b>						
<i>F-test all</i>	0	0,01	0,00	0,00	0,00	0,07
<i>F-test before</i>	0,01	0,00	0,07	0,01	0,00	0,82
<i>F-test after</i>	0,17	0,05	0,04	0,04	0,11	0,07
<b>RESRFIT</b>						
<i>F-test all</i>	0,03	0,03	0,01	0,00	0,05	0,11
<i>F-test before</i>	0,00	0,01	0,04	0,00	0,01	0,01
<i>F-test after</i>	0,95	0,02	0,46	0,09	0,54	0,85
<b>RESROTH</b>						
<i>F-test all</i>	0,03	0,03	0,01	0,00	0,05	0,11

<i>F-test before</i>	0,02	0,01	0,17	0,00	0,00	0,83
<i>F-test after</i>	0,35	0,02	0,04	0,01	0,13	0,09
<i>DIRDUM</i>						
<i>F-test all</i>	0,03	0,03	0,01	0,00	0,05	0,11
<i>F-test before</i>	0,01	0,01	0,01	0,00	0,01	0,04
<i>F-test after</i>	0,99	0,15	0,96	0,10	0,82	0,85

It is very interesting to observe that Table I statistics give us a (preliminary) indicator on the efficacy of RES regulation: looking at column one which shows the results for the emissions variable we can see that the cross-country differences in average emissions were significant before the enactment of all types of regulation whether the variable is RESRALL or decomposed in RESRFIT and RESROTH but they become insignificant after it. The same is the case with DIRDUM variable. These results offer preliminary but corroborating evidence of the significant effect that RES regulation, as a whole or decomposed, has towards a common path on CO<sub>2</sub> emissions across the EU-15 countries.

Furthermore, in our earlier work where all RES regulation was aggregated in one variable, we found that there were significant differences in the use of total fossil fuel consumption across countries before the enactment of RES regulation but there are no such differences after, while the opposite was the case for the total final energy consumption (Alexopoulos, Thomakos & Tzavara, 2012). What we see here, relative to fossil fuel consumption and total final energy consumption is that similar effects (differences across countries before the enactment of RES regulation becoming insignificant after in fossil fuel consumption and the opposite for total energy consumption) pertain when we look at RESROTH, which aggregates all other measures except feed-in tariffs. But when we look at feed-in tariffs and the common framework directive, we see that the effect of cross-country differences becoming insignificant after the introduction of RES regulation carries over to total energy consumption as well as fossil fuel consumption. Note that there appears to be a stronger effect from regulation on the growth of natural gas and coal consumption but not on petroleum consumption – a

result that will re-appear later in our estimation result.

The ‘convergence’ effect on the composition of the fossil fuel mix across EU-15 countries that we found in Alexopoulos, Thomakos & Tzavara (2012), seems to preserve when we decompose RES regulation into feed-in tariffs and all other measures, as well as when we look at the effect of the common framework directive. RES regulation appears to have a positive effect on a common energy policy in the production mix of all the EU-15 countries, and this effect preserves whether we are looking at feed-in tariffs or at all other measures taken across countries. This is in-line with the results on the effects on natural gas and coal, which point towards increased substitutability effects. On the other hand, the ‘divergence’ effect on final energy consumption that we found in Alexopoulos, Thomakos & Tzavara (2012), which we perceived as an indicator of cross-country differences, seems to preserve only when we consider the aggregate of all other measures except feed-in tariffs. Looking at feed-in tariffs and the common framework directive, we observe that there is some evidence of ‘convergence’ on final energy consumption as well, after the introduction of both. What this indicates is that when we are looking at final energy consumption, the policy mix plays a role and points to the direction of further research.

#### IV. METHODOLOGY

We expand on our earlier empirical models so as to compare the effects of the three kinds of regulatory measures we consider. Based on those models we still anticipate a positive effect from RES regulation on reducing CO<sub>2</sub> emissions – after accounting for the main sources of emissions (fossil fuel mix and the final energy consumption mix); here, however, we can compare different sources and approaches to regulation. Since we work with a fixed cross-sectional dimension and increasing time dimension we can use traditional panel estimation methods and we do so in what follows. In the models that follow we consider the divisions of the fuel mix and use the aggregate of all components on



the energy consumption mix; however, additional results on the decomposition of the energy consumption mix are also available but not presented here.

Since the RES regulation variables are binary ones, a straightforward way to assessing their efficacy in reducing emissions – and identifying the source of that efficacy in the explanatory variables – is to use a model with interactions. Such models allow for changing coefficients and they are well defined since  $D_{it}$  is also well, and exogenously, defined. To ensure that the effect of RES regulation is actually present we estimate three different types of models with three different estimation methods, following a top-down approach using specification testing. The rest of the presentation of the models follows directly from Alexopoulos, Thomakos & Tzavara (2012).

The first model we consider includes the  $D_{it}$  variable and also the components of the fossil fuel mix, along with the interactions, as in equation (1) below.

$$CO2_{it} = c_i + \delta_0 D_{it} + \gamma_1 PC_{it} + \delta_1 D_{it} PC_{it} + \gamma_2 CC_{it} + \delta_2 D_{it} CC_{it} + \gamma_3 NGC_{it} + \delta_3 D_{it} NGC_{it} + \varepsilon_{it} \quad (1)$$

If  $D_{it}$  is indeed beneficial in reducing emissions then we should have in the above specification that  $\delta_j < 0$  for all  $j = 0, 1, 2, 3$ . We estimate the above equation both in log-levels and in log-differences using either pooled least squares (LS), fixed effects (FE) or random effects (RE), based on specification testing.<sup>1</sup>

The second model we consider includes the aggregates of both the fossil fuel consumption and the final energy consumption, i.e. it takes the form of:

$$CO2_{it} = c_i + \delta_0 D_{it} + \gamma_1 TFC_{it} + \delta_1 D_{it} TFC_{it} + \gamma_2 TEC_{it} + \delta_2 D_{it} TEC_{it} + \varepsilon_{it} \quad (2)$$

where we have a similar interpretation for the parameters and which is estimated using the same approach as the one for equation (1).

Finally, we consider a third model based on an “error correction” approach which we now explain. All three aggregate variables,  $CO2_{it}$ ,  $TFC_{it}$  and  $TEC_{it}$  are trending variables and they may follow common stochastic trends. Panel cointegration tests, not reported here, indicate the presence of cointegration among these three variables (and allow us to have a direct interpretation for the results of equation (2)). The presence of a common trend motivates us to consider the “error correcting”, or cointegrating, component as an explanatory variable in the growth rate of the emissions and to build two models. The first model is given by:

$$\Delta CO2_{it} = c_i + \delta_0 D_{it} + \alpha (CO2_{i,t-1} - \beta_1 TEC_{i,t-1} - \beta_2 TFC_{i,t-1}) + \alpha_D D_{it} (CO2_{i,t-1} - \beta_1 TEC_{i,t-1} - \beta_2 TFC_{i,t-1}) + \varepsilon_{it} \quad (3a)$$

where we consider the three variables together and build the single-equation component of a full system. The cointegrating component has switching coefficients and therefore the contribution of the RES regulation can be assessed here as well: we expect that the speed-of-adjustment coefficients  $\alpha < 0$  and  $\alpha_D < 0$  are both negative and we have that  $\alpha > \alpha + \alpha_D$ , i.e. the speed of adjustment is faster after the enactment of the RES regulation. Next, we consider another model that takes the form:

$$\Delta CO2_{it} = c_i + \delta_0 D_{it} + \alpha (TEC_{it} - \beta TFC_{it}) + \alpha_D D_{it} (TEC_{it} - \beta TFC_{it}) + \varepsilon_{it} \quad (3b)$$

where we now remove the emissions part from the right-hand side and consider the (again cointegrating) pair of the energy consumption and fossil fuel consumption variables. The interpretation of the coefficients is the same as in the previous equation. Both equations (3a) and (3b) are estimated by FE or pooled LS depending on specification testing.

Each of the above equations is estimated three times, once using the regulation variable for RESRFIT and then again using the regulation variable for RESROTH and again using the

<sup>1</sup> In FE and pooled LS estimation we use GLS with cross-section weights or cross-section SUR weights. In all estimations we report robust standard errors.

directive variable DIRDUM. Along with the results of RESRALL from our earlier work, to which we refer for comparison purposes, we present these separate estimations but we also present results that correspond to tests of statistical significance of the differences from the use of the two measures, as well as the common framework directive. We discuss these tests in the next section.

## V. DISCUSSION OF RESULTS

All our estimation results are reported in Tables II and III that follow. In Table II we have the results based on the model of equation (1) while in Table III we have the results based on the models of equations (2), (3a) and (3b). As mentioned before, for each model we present four different, corresponding tables (where each of the tables with a suffix a, b, c correspond to the use of the new regulation variables RESRFIT, RESROTH and DIRDUM respectively). The initial tables II and III, without the suffixes, are from Alexopoulos, Thomakos & Tzavara (2012) and are presented here for the purpose of comparison.

Comparing with Table II, which reproduces results from our earlier work, we see that Tables IIa and IIb report similar effects relative to the effect of regulation on CO<sub>2</sub> emissions and the decomposition of the effect based on the fossil fuel mix. In Table IIc we see differentiation relative to the effect of the fossil fuel mix. First, we see that, both for feed-in tariffs as well as for all other measures, all the interactive estimates, save that on petroleum consumption, are negative and statistically significant. That is, the estimates of the parameters  $\hat{\delta}_0, \hat{\delta}_2, \hat{\delta}_3$  are all negative, as required for an emissions-reducing effect. In the case of the common framework directive,  $\hat{\delta}_0, \hat{\delta}_2$  are negative and significant, the natural gas interactive estimate is positive but very close to zero, while the petroleum interactive estimate is positive. Second, in all Tables IIa, IIb, and IIc, the magnitude of the estimates of petroleum consumption are larger than the combined magnitude of coal and natural gas consumption, i.e. we see that  $\hat{\gamma}_1 > \hat{\gamma}_2 + \hat{\gamma}_3$ . Third, in

all Tables IIa, IIb and IIc, the combined estimates of the parameters after RES regulation are either zero or slightly positive, i.e. we see that  $\hat{\delta}_1 + \hat{\delta}_2 + \hat{\delta}_3 \approx 0$ . Note that the effect of the feed-in tariffs (IIa) is larger in magnitude than the effects of either the combined measure of our earlier work (Table II) or the effect of all other regulation measures (Table IIb). A formal test (not presented here) shows that in the presence of the feed-in tariffs the effect of the other regulation measures becomes insignificant. Also, note that the effect of the common framework directive (Table IIc) is larger in magnitude than that of the combined RES measure (Table II). Our take on these results is as follows (where we use the numbers of the model estimated by FE as an illustration).

Table II  
Estimation results for equation (1)

RESRALL				
Explanatory variables		FE in levels	LS in diff/s	RE in levels
c	Estimate	-3.43	0.00	-1.56
	t-statistic	13.66	0.20	3.69
D	Estimate	-0.15	0.00	-0.22
	t-statistic	-3.58	1.44	3.54
PC or ΔPC	Estimate	0.53	0.40	0.37
	t-statistic	23.03	12.81	9.13
D×PC or D×ΔPC	Estimate	0.11	0.20	0.11
	t-statistic	9.28	3.19	7.07
CC or ACC	Estimate	0.22	0.25	0.18
	t-statistic	25.66	12.62	16.67
D×CC or D×ACC	Estimate	-0.07	-0.07	-0.06
	t-statistic	-9.90	-2.87	-5.45
NGC or ΔNGC	Estimate	0.05	0.08	0.08
	t-statistic	11.23	4.21	13.60
D×NGC or D×ΔNGC	Estimate	-0.02	-0.05	-0.03
	t-statistic	-5.61	2.59	4.65
Tests & Diagnostics				
N×T		423	408	423
R <sup>2</sup>		0.99	0.47	0.74
S = D×PC+D×CC+D×NGC or S = D×ΔPC+D×ΔCC+D×ΔNGC		0.01	0.08	0.02
p-value of test S = 0		0.00	0.25	0.00
p-value of test for redundant fixed effects		0.00	0.61	n.a.
p-value of test for correlated random effects		n.a.	n.a.	0.00

Table IIa  
Estimation results for equation (1)

RESRFTT				
Explanatory variables		FE in levels	LS in diff/s	RE in levels
c	Estimate	-3,65	0,00	-2,27
	t-statistic	-13,01	1,21	-4,82
D	Estimate	-0,18	0,00	-0,36
	t-statistic	-3,60	0,72	-4,46
PC or ΔPC	Estimate	0,57	0,44	0,44
	t-statistic	22,54	11,33	9,45
D×PC or D×ΔPC	Estimate	0,10	0,10	0,13
	t-statistic	8,75	1,28	7,32
CC or ΔCC	Estimate	0,20	0,22	0,18
	t-statistic	23,91	17,92	17,08

$D \times CC$ or $D \times \Delta CC$	<i>Estimate</i>	-0,07	-0,02	-0,07
	<i>t-statistic</i>	-12,87	-1,10	-7,82
$NGC$ or $\Delta NGC$	<i>Estimate</i>	0,049	0,03	0,07
	<i>t-statistic</i>	12,47	3,57	10,74
$D \times NGC$ or $D \times \Delta NGC$	<i>Estimate</i>	-0,02	-0,00	-0,03
	<i>t-statistic</i>	-4,10	-0,77	-3,57
<b>Tests &amp; Diagnostics</b>				
$N \times T$		423	408	423
$R^2$		0,99	0,47	0,78
$S = D \times PC + D \times CC + D \times NGC$ or $S = D \times \Delta PC + D \times \Delta CC + D \times \Delta NGC$		0,01	0,07	0,03
<i>p-value of test <math>S = 0</math></i>		0,00	0,37	0,00
<i>p-value of test for redundant fixed effects</i>		0,00	0,65	n,a
<i>p-value of test for correlated random effects</i>		n,a	n,a	0,00

The presence of the any RES regulation measure as well as the directive contributes to a fixed reduction in the level of emissions, as can be seen by the negative estimate of  $\hat{\delta}_0$  in all the tables.<sup>2</sup> Furthermore, RES regulation reduces or keeps (almost) unchanged in the case of DIRDUM, the marginal contribution of the use of coal and natural gas, as can be seen by the estimates of  $\hat{\delta}_2$  and  $\hat{\delta}_3$ . However, the marginal contribution to emissions from the use of petroleum is increased and all estimates are still positive after the RES regulation enactment (either in the form of feed-in tariffs or in the form of all other measures, or in the form of the common framework directive), i.e. the estimates of the sum  $\hat{\gamma}_j + \hat{\delta}_j > 0$ , for  $j = 1, 2, 3$ . Note how this last result on the effect of petroleum is relative to our earlier discussion surrounding Table I.

Table IIb  
Estimation results for equation (1)

<b>RESROTH</b>				
<b>Explanatory variables</b>		<b>FE in levels</b>	<b>LS in diff/s</b>	<b>RE in levels</b>
$c$	<i>Estimate</i>	-3,40	0,00	-1,55
	<i>t-statistic</i>	13,65	0,20	-3,67
$D$	<i>Estimate</i>	-0,14	0,00	-0,20
	<i>t-statistic</i>	-3,19	1,44	-3,37
$PC$ or $\Delta PC$	<i>Estimate</i>	0,53	0,39	0,36
	<i>t-statistic</i>	23,00	12,84	9,10
$D \times PC$ or $D \times \Delta PC$	<i>Estimate</i>	0,10	0,20	0,11
	<i>t-statistic</i>	9,13	3,20	6,98
$CC$ or $\Delta CC$	<i>Estimate</i>	0,22	0,24	0,18
	<i>t-statistic</i>	25,86	12,77	16,60
$D \times CC$ or $D \times \Delta CC$	<i>Estimate</i>	-0,07	-0,07	-0,06

<sup>2</sup> Note that both in Table II and Table III the estimate of  $\hat{\delta}_0$  becomes statistically insignificant when we estimate the model in differences. In all other cases it remains negative and statistically significant. The reason is that differencing removes the constant cross-country heterogeneity and so the effect is concentrated on the interaction coefficients.

	<i>t-statistic</i>	-9,89	-2,92	-5,49
$NGC$ or $\Delta NGC$	<i>Estimate</i>	0,05	0,08	0,08
	<i>t-statistic</i>	11,37	4,20	13,56
$D \times NGC$ or $D \times \Delta NGC$	<i>Estimate</i>	-0,024	-0,05	-0,03
	<i>t-statistic</i>	-5,64	-2,59	-4,60
<b>Tests &amp; Diagnostics</b>				
$N \times T$		423	408	423
$R^2$		0,99	0,47	0,74
$S = D \times PC + D \times CC + D \times NGC$ or $S = D \times \Delta PC + D \times \Delta CC + D \times \Delta NGC$		0,01	0,08	0,02
<i>p-value of test <math>S = 0</math></i>		0,00	0,25	0,00
<i>p-value of test for redundant fixed effects</i>		0,00	0,61	n,a
<i>p-value of test for correlated random effects</i>		n,a	n,a	0,00

Table IIc  
Estimation results for equation (1)

<b>DIRDUM</b>				
<b>Explanatory variables</b>		<b>FE in levels</b>	<b>LS in diff/s</b>	<b>RE in levels</b>
$c$	<i>Estimate</i>	-1,97	0,00	-2,13
	<i>t-statistic</i>	-3,97	2,04	-4,64
$D$	<i>Estimate</i>	-0,24	-0,00	-0,24
	<i>t-statistic</i>	-3,67	1,90	-3,67
$PC$ or $\Delta PC$	<i>Estimate</i>	0,42	0,46	0,42
	<i>t-statistic</i>	8,68	12,39	9,38
$D \times PC$ or $D \times \Delta PC$	<i>Estimate</i>	0,09	0,02	0,09
	<i>t-statistic</i>	6,12	0,26	5,77
$CC$ or $\Delta CC$	<i>Estimate</i>	0,18	0,23	0,18
	<i>t-statistic</i>	21,03	16,52	21,77
$D \times CC$ or $D \times \Delta CC$	<i>Estimate</i>	-0,08	-0,05	-0,08
	<i>t-statistic</i>	-9,01	-2,63	-8,75
$NGC$ or $\Delta NGC$	<i>Estimate</i>	0,07	0,03	0,08
	<i>t-statistic</i>	8,97	5,65	8,85
$D \times NGC$ or $D \times \Delta NGC$	<i>Estimate</i>	0,01	0,15	0,01
	<i>t-statistic</i>	2,95	7,16	2,29
<b>Tests &amp; Diagnostics</b>				
$N \times T$		423	408	423
$R^2$		0,99	0,49	0,77
$S = D \times PC + D \times CC + D \times NGC$ or $S = D \times \Delta PC + D \times \Delta CC + D \times \Delta NGC$		0,02	0,13	0,02
<i>p-value of test <math>S = 0</math></i>		0,00	0,11	0,00
<i>p-value of test for redundant fixed effects</i>		0,00	0,61	n,a
<i>p-value of test for correlated random effects</i>		n,a	n,a	0,00

A possible explanation for the higher  $D$  estimate of RESRIT, in comparison with those of RESRALL and RESROTH, renders it the most effective measure in the reduction of CO<sub>2</sub> emissions. Also, as discussed above, feed-in tariffs are the most popular measures among European countries and, as evidence suggests, the most effective in achieving RES development. The dynamics that we observe working together in our estimation are: on the one hand increased demand for energy which maintains positive marginal rates from all fossil fuel components and on the other hand an ambiguous marginal effect of RES regulation from the use of fossil fuels. In the case of

both RESRFIT and RESROTH, we observe a reduction in the marginal effects from the use of coal and natural gas and an increase in the marginal effect from the use of petroleum. In the case of the DIRDUM, this reduction is only observed from the use of coal, while there is an increase in the marginal effect from the use of petroleum and a (almost) neutral effect from the use of natural gas. There are some facts to consider here, in order to understand the direction and magnitude of these effects. Concerning fuel consumption, we should consider that the share of RES in the production (fuel mix) and consumption of energy is still very small (Eurostat, 2011). Also, because of the nature of energy produced from RES, this is used to cover only peak energy demands while most of the base load demands are covered by thermal (fossil fuel) power stations. Rising economic growth<sup>3</sup> and demand of higher standards of living and technology require more and more energy, which is still being serviced to a large part via thermal power stations that depend on fossil fuels. As a result of these observations, RES regulation, be it in the form of feed-in tariffs or any other measure, should be expected to reduce the rate of increase of CO<sub>2</sub> emissions before actually reducing emissions.

We turn next to the estimation results in Tables III, from our second group of models, in equations (2) and (3a), (3b). Table III reproduces our earlier findings (Alexopoulos, Thomakos & Tzavara, 2012, p. 6), and Tables IIIa, IIIb, and IIIc capture the effects of RESRFIT, RESROTH and DIRDUM respectively. We find some similar qualitative characteristics with tables IIa, IIb, and IIc, but also some interesting differences. Also, we find comparable results with those of our earlier work, but again some interesting differences as well. Starting from the model in equation (2), when we estimate it in first differences, we find that while the marginal contributions, before the RES regulation enactment, from the growth rates of total fuel mix and total energy consumption are positive, those

signs become negative only for total energy consumption after the RES regulation enactment (RESRFIT, RESROTH, DIRDUM), and in the case of RESROTH those marginal contributions are of equal magnitude, i.e. we find that  $\hat{\delta}_1 + \hat{\delta}_2 = 0$ . These opposite signs tell us that in terms of rates of change the primary effect of the different types of RES-regulation goes through the aggregate of final energy consumption and not the fuel mix consumption.

Table III  
Estimation results for equations (2), (3a) and (3b)

RESRALL					
Explanatory Variables & Parameters		LS in diff/s	RE in levels	EC #1	EC #2
C	Estimate	0.00	-6.42	0.40	-0.59
	t-statistic	0.16	16.44	0.64	1.28
D	Estimate	0.00	-0.22	-0.48	-0.12
	t-statistic	0.56	3.27	3.12	1.82
TFC or $\Delta TFC$	Estimate	0.53	0.39		
	t-statistic	31.73	10.93		
D×TFC or D× $\Delta TFC$	Estimate	0.09	0.09		
	t-statistic	5.25	6.50		
TEC or $\Delta TEC$	Estimate	0.53	0.66		
	t-statistic	16.30	20.87		
D×TEC or D× $\Delta TEC$	Estimate	-0.10	-0.07		
	t-statistic	2.92	4.61		
$\alpha$	Estimate			-0.18	-0.11
	t-statistic			2.40	4.14
$\alpha_D$	Estimate			-0.07	-0.01
	t-statistic			4.10	1.76
$\beta$	Estimate				1.42
	t-statistic				4.50
$\beta_D$	Estimate				1.70
	t-statistic				3.13
$\beta_1$	Estimate			0.07	
	t-statistic			0.17	
$\beta_{1D}$	Estimate			0.69	
	t-statistic			4.83	
$\beta_2$	Estimate			0.17	
	t-statistic			0.64	
$\beta_{2D}$	Estimate			0.36	
	t-statistic			2.71	
Tests & Diagnostics					
$N \times T$		285	300	285	300
$R^2$		0.65	0.94	0.17	0.15
$S = D \times TFC + D \times TEC$ or $S = D \times \Delta TFC + D \times \Delta TEC$		0.00	0.01	n.a.	n.a.
p-value of test $S = 0$		0.74	0.01	n.a.	n.a.
p-value of test for redundant fixed effects		0.09	n.a.	0.00	0.00
p-value of test for correlated random effects		n.a.	0.07	n.a.	n.a.
p-value of test $TFC = TEC$		0.76	0.00	n.a.	n.a.
p-value of test $\beta = \beta_D$ or $\beta_1 = \beta_{1D}$ and $\beta_2 = \beta_{2D}$		n.a.	n.a.	0.14	0.71

Table IIIa  
Estimation results for equations (2), (3a) and (3b)

RESRFIT					
Explanatory Variables & Parameters		LS in diff/s	RE in levels	EC #1	EC #2
c	Estimate	0.00	-6.69	-0.84	0.09
	t-statistic	2.45	34.25	-3.68	10.39
D	Estimate	-0.00	-0.40	-0.48	-0.09
	t-statistic	-1.62	-9.30	-9.48	-5.86
TFC or $\Delta TFC$	Estimate	0.46	0.37		
	t-statistic	23.50	6.48		
D×TFC or	Estimate	0.21	0.06		

<sup>3</sup> All our estimations were repeated using real GDP growth as an explanatory variable. In most cases the results were of the right sign (negative) but of small magnitude which was inconsequential compared to the fossil fuel and energy consumption variables. Detailed results with GDP included are also available.

$D \times \Delta TFC$	<i>t</i> -statistic	7,075	8,69		
$TEC$ or $\Delta TEC$	<i>Estimate</i>	0,51	0,70		
	<i>t</i> -statistic	19,48	12,10		
$D \times TEC$ or $D \times \Delta TEC$	<i>Estimate</i>	-0,14	-0,02		
	<i>t</i> -statistic	-3,54	-3,47		
$\alpha$	<i>Estimate</i>			-0,38	-0,01
	<i>t</i> -statistic			17,24	-10,11
$\alpha_D$	<i>Estimate</i>			0,48	0,43
	<i>t</i> -statistic			9,36	4,84
$\beta$	<i>Estimate</i>				0,01
	<i>t</i> -statistic				7,89
$\beta_D$	<i>Estimate</i>				0,45
	<i>t</i> -statistic				3,29
$\beta_1$	<i>Estimate</i>		0,17		
	<i>t</i> -statistic		6,72		
$\beta_{1D}$	<i>Estimate</i>		-0,02		
	<i>t</i> -statistic		-3,57		
$\beta_2$	<i>Estimate</i>		0,79		
	<i>t</i> -statistic		6,42		
$\beta_{2D}$	<i>Estimate</i>		1,33		
	<i>t</i> -statistic		4,21		
<b>Tests &amp; Diagnostics</b>					
$N \times T$		285	300	285	300
$R^2$		0,66	0,95	0,18	0,05
$S = D \times TFC + D \times TEC$ or $S = D \times \Delta TFC + D \times \Delta TEC$		0,07	0,03	n.a.	n.a.
<i>p</i> -value of test $S = 0$		0,00	0,00	n.a.	n.a.
<i>p</i> -value of test for redundant fixed effects		0,09	n.a.	0,00	0,00
<i>p</i> -value of test for correlated random effects		n.a.	0,03	n.a.	n.a.
<i>p</i> -value of test $TFC = TEC$		0,25	0,00	n.a.	n.a.
<i>p</i> -value of test $\beta = \beta_D$ or $\beta_1 = \beta_{1D}$ and $\beta_2 = \beta_{2D}$		n.a.	n.a.	0,62	0,71

Table IIIb  
Estimation results for equations (2), (3a) and (3b)

RESROTH					
Explanatory Variables & Parameters		FE in diff/s	RE in levels	EC #1	EC #2
$c$	<i>Estimate</i>	-0,01	-6,42	0,40	-0,59
	<i>t</i> -statistic	-98,55	-15,93	0,64	-1,27
$D$	<i>Estimate</i>	0,001	-0,19	-0,48	-0,10
	<i>t</i> -statistic	74,70	-2,707	-3,12	-1,61
$TFC$ or $\Delta TFC$	<i>Estimate</i>	0,49	0,397		
	<i>t</i> -statistic	519,86	10,67		
$D \times TFC$ or $D \times \Delta TFC$	<i>Estimate</i>	0,18	0,084		
	<i>t</i> -statistic	168,60	5,937		
$TEC$ or $\Delta TEC$	<i>Estimate</i>	0,70	0,65		
	<i>t</i> -statistic	280,28	20,96		
$D \times TEC$ or $D \times \Delta TEC$	<i>Estimate</i>	-0,17	-0,07		
	<i>t</i> -statistic	-79,80	-4,47		
$\alpha$	<i>Estimate</i>			-0,18	-0,11
	<i>t</i> -statistic			-2,40	-4,15
$\alpha_D$	<i>Estimate</i>			0,07	1,41
	<i>t</i> -statistic			0,16	4,50
$\beta$	<i>Estimate</i>				-0,01
	<i>t</i> -statistic				-1,74
$\beta_D$	<i>Estimate</i>				1,63
	<i>t</i> -statistic				3,16
$\beta_1$	<i>Estimate</i>		0,16		
	<i>t</i> -statistic		0,64		
$\beta_{1D}$	<i>Estimate</i>		-0,07		
	<i>t</i> -statistic		-4,10		
$\beta_2$	<i>Estimate</i>		0,68		
	<i>t</i> -statistic		4,83		
$\beta_{2D}$	<i>Estimate</i>		0,35		
	<i>t</i> -statistic		2,70		
<b>Tests &amp; Diagnostics</b>					
$N \times T$		285	300	285	300
$R^2$		0,66	0,94	0,17	0,15
$S = D \times TFC + D \times TEC$ or $S = D \times \Delta TFC + D \times \Delta TEC$		0,00	0,01	n.a.	n.a.
<i>p</i> -value of test $S = 0$		0,00	0,04	n.a.	n.a.

<i>p</i> -value of test for redundant fixed effects	0,00	n.a.	0,00	0,00
<i>p</i> -value of test for correlated random effects	n.a.	0,08	n.a.	n.a.
<i>p</i> -value of test $TFC = TEC$	0,00	0,00	n.a.	n.a.
<i>p</i> -value of test $\beta = \beta_D$ or $\beta_1 = \beta_{1D}$ and $\beta_2 = \beta_{2D}$	n.a.	n.a.	0,14	0,76

Table IIIc  
Estimation results for equations (2), (3a) and (3b)

DIRDUM					
Explanatory Variables & Parameters		FE in diff/s	RE in levels	EC #1	EC #2
$c$	<i>Estimate</i>	-0,00	-7,07	0,04	0,01
	<i>t</i> -statistic	>500	-20,44	0,05	3,76
$D$	<i>Estimate</i>	-0,00	-0,17	0,19	-0,11
	<i>t</i> -statistic	-328	-3,80	1,73	-3,69
$TFC$ or $\Delta TFC$	<i>Estimate</i>	0,46	0,39		
	<i>t</i> -statistic	>500	6,50		
$D \times TFC$ or $D \times \Delta TFC$	<i>Estimate</i>	0,28	0,04		
	<i>t</i> -statistic	>500	5,15		
$TEC$ or $\Delta TEC$	<i>Estimate</i>	0,78	0,72		
	<i>t</i> -statistic	>500	18,76		
$D \times TEC$ or $D \times \Delta TEC$	<i>Estimate</i>	-0,33	-0,03		
	<i>t</i> -statistic	>500	-5,52		
$\alpha$	<i>Estimate</i>			-0,23	-0,11
	<i>t</i> -statistic			-3,43	-4,15
$\alpha_D$	<i>Estimate</i>			0,03	0,01
	<i>t</i> -statistic			1,87	3,45
$\beta$	<i>Estimate</i>				
	<i>t</i> -statistic				
$\beta_D$	<i>Estimate</i>				
	<i>t</i> -statistic				
$\beta_1$	<i>Estimate</i>			0,50	
	<i>t</i> -statistic			1,65	
$\beta_{1D}$	<i>Estimate</i>			0,89	
	<i>t</i> -statistic			2,93	
$\beta_2$	<i>Estimate</i>			-0,05	
	<i>t</i> -statistic			0,21	
$\beta_{2D}$	<i>Estimate</i>			0,20	
	<i>t</i> -statistic			0,77	
<b>Tests &amp; Diagnostics</b>					
$N \times T$		285	300	285	300
$R^2$		0,67	0,95	0,14	0,04
$S = D \times TFC + D \times TEC$ or $S = D \times \Delta TFC + D \times \Delta TEC$		-0,05	0,01	n.a.	n.a.
<i>p</i> -value of test $S = 0$		0,00	0,00	n.a.	n.a.
<i>p</i> -value of test for redundant fixed effects		0,00	n.a.	0,00	0,00
<i>p</i> -value of test for correlated random effects		n.a.	1,00	n.a.	n.a.
<i>p</i> -value of test $TFC = TEC$		0,00	0,00	n.a.	n.a.
<i>p</i> -value of test $\beta = \beta_D$ or $\beta_1 = \beta_{1D}$ and $\beta_2 = \beta_{2D}$		n.a.	n.a.	0,22	n.a.

The same findings pertain when we estimate in levels via RE, namely, we still have find a negative estimate in front of final energy consumption and a positive estimate in front of the fuel mix, after the enactment of any type of RES regulation. Comparing with our earlier findings, where we had one variable aggregating all RES regulation, our findings show that on this (fuel and energy consumption) aggregate level, the effect of RES-regulation goes through the energy demand side. This is true both for feed-in tariffs and for all other measures, but it is also true for the effect of the common framework directive. On the energy

demand side, this is an indication that RES regulation is a driver towards more rational use of energy and works together to this direction with energy efficiency policies implemented in different countries.

Turning, finally, to the estimation results from the error correction models we can see that the emissions-reducing effect of RES-regulation goes through again, although the results are not as cohesive with the specific measures as it was with the combined measure of our earlier work. The estimates of the  $\hat{\delta}_0$  terms are again negative and significant, with the exception of the DIRDUM in model (3a). The estimated speed-of-adjustment estimates  $\hat{\alpha}, \hat{\alpha}_D$  in both models are negative before the enactment of regulation but turn positive after the enactment, however, with decreased magnitude or they become less significant when we consider the individual measures. This is in contrast with our earlier results that appear in Table III, compared to the new results in Tables IIIa and IIIb. This could be interpreted as some form of evidence that the dynamic adjustment (and not just the transition to new equilibrium values) towards lower levels of emissions requires a combination of regulation measures so that it can happen faster.

## VI. CONCLUSIONS

In this study we look at the effectiveness of different sources of regulation to promote RES relative to reducing CO<sub>2</sub> emissions. We also look at the effect of the first EU directive to promote renewable sources (2001/77/EC) on the evolution of CO<sub>2</sub> emissions. To do this we use data from the EU-15 countries on CO<sub>2</sub> emissions, the fuel mix and final energy consumption and use panel-based estimation methods. To capture the effect of RES regulation, we construct two new variables which account for all RES regulation measures taken across EU-15 countries, grouping RES regulation into two categories: (i) feed-in tariff measures and (ii) all other measures. We also construct a third variable which captures the effect of 2001/77/EC directive for the promotion of the use of RES, which introduced a common framework for the promotion of RES across European countries.

Together with our earlier research (Alexopoulos, Thomakos & Tzavara, 2012) on the link between RES regulation and CO<sub>2</sub> emissions, this study aims at shedding more light on the question of how RES regulation affects the evolution of CO<sub>2</sub> emissions. There is an open debate in the literature regarding the effectiveness of different policy instruments and measures in achieving the promotion of RES. Also, RES are considered as key to the implementation of international agreements for the reduction of GHG to the direction of combating climate change (Commission of the European Communities, 2009; European Wind Energy Association, 2011). For these reasons, we believe that it is important to understand the role of RES regulation and of the different policy instruments in reducing CO<sub>2</sub> emissions.

The first thing that we find is that, feed-in tariff RES regulation, all other RES measures as well as the common framework directive introduce some ‘convergence’ on the composition of the fossil fuel mix used across EU-15 countries. This evidence of ‘convergence’ is carried over to energy consumption in the case of the directive, while the result is reversed for feed-in tariffs and all other RES regulation. In the case of feed-in tariffs and all other RES regulation, we find ‘divergence’ in the use of power generated across EU-15 countries. is an element that captures differences in the economies of EU-15 countries. The implications of these findings are that, relative to ‘convergence’ in the fuel mix, the implementation of the harmonized policy towards RES can be a catalyst in achieving the 20% share target. Relative to energy consumption, the evidence of ‘divergence’ highlights differences across countries and points to the direction of further research.

We find that both feed-in tariff RES regulation as well as the aggregate of all other RES regulation measures have a positive effect on reducing CO<sub>2</sub> emissions across EU-15 countries. Also, the same is true for the 2001/77/EC directive, which introduces a common framework across European countries for the promotion of RES in the energy mix. These effects are reflected in the negative coefficients of the RES regulation variables. These findings justify

the emphasis placed by the EU on the regulation of RES and on establishing a common framework across European countries.

Also, we find that the effect of feed-in tariffs measures has a greater impact in the reduction of CO<sub>2</sub> emissions than the aggregate of all other RES measures variable. Moreover, feed-in tariffs have a greater effect on the reduction of CO<sub>2</sub> emissions compared to the aggregate variable which combines together all RES measures, including feed-in tariffs (from our previous research). There seems to be wide agreement among many observers that feed-in tariffs are more effective in promoting RES use than other instruments and measures (Meyer, 2003; Lauder, 2004; Rowlands, 2004; Held, Ragwitz and Haas, 2006; Mendonca, 2007). Even more so, it has been argued that there is evidence that when feed-in tariffs were in effect, in combination with other measures, and were removed from the policy mix, leaving the promotion of renewables to other policy measures, the development of RES slowed down (Lauber, 2004; Rowlands, 2004; Mendoca, 2007). This effectiveness of feed-in tariffs in the development of RES sources seems to be reflected in the evolution of CO<sub>2</sub> emissions. Being effective relative to one target (the promotion of RES), feed-in tariffs seems to be effective relative to the other target as well, namely to that of cutting down emissions.

Besides the overall effect of different types of RES regulation on CO<sub>2</sub> emissions, reflected in the negative coefficient of the RES regulation variables, there are also indirect effects from the fuel mix as well as from the aggregate of that and from the aggregate energy consumption. Relative to the fuel mix, we find indirect effects of the different types of RES regulation which move to different directions. On the one hand, RES regulation puts downward pressure on CO<sub>2</sub> emissions through the use of coal and natural gas, both in the case of feed-in tariffs as well as all other measures. When we look at the common framework directive, there is a negative effect to CO<sub>2</sub> emissions through the use of coal, while the effect is neutral in the case of natural gas. In all three cases, our RES variables put upward pressure to emissions through the use of

petroleum. What this says is that the fuel mix plays an important role in determining the effectiveness of RES regulation towards achieving emission targets. For example, it is the case that petroleum takes the larger share of fossil fuel consumption (World Resources Institute, 2006) and that among fossil fuel subsidies, world subsidies to oil consumption in 2010 were almost double of those for coal and natural gas combined (IEA, 2011). The latter suggests that if RES are to play a role in achieving emission targets, then policy to promote the use of RES should work hand-in-hand with energy policy.

Finally, we find that the negative effect of RES regulation on emissions, both for feed-in tariffs as well as for all other measures, but also for the common framework directive, is reflected through final energy consumption. The implication of this finding is that energy preservation policies should be combined with policies to promote the use of RES, as it seems that the effect of one could boost that of the other kind of policy.

To sum up, our findings that our three types of measures to promote RES regulation put downward pressure on CO<sub>2</sub> emissions, suggest that the focus of attention of EU policies on RES regulation is in the right direction. This suggests that there is need to focus research on the different aspects of how RES can affect CO<sub>2</sub> emissions. Some other aspects of this problem which we are investigating further to this research include, a deeper look into the cross-country differences on RES-regulation, the inclusion of other explanatory variables and the generation of emission simulation scenarios based on the efficacy of RES and other types of regulation.

## VII. REFERENCES

- ABB (2001). *Germany, Energy Efficiency Report*. [Online]. Available: [http://www05.abb.com/global/scot/scot316.nsf/veritydisplay/5793753d3056bfb4c12578640051183f/\\$file/germany.pdf](http://www05.abb.com/global/scot/scot316.nsf/veritydisplay/5793753d3056bfb4c12578640051183f/$file/germany.pdf)
- Alexopoulos, Thomakos and Tzavara (2012), "CO<sub>2</sub> emissions, fuel mix, final energy consumption and regulation of renewable energy sources in the EU-15", IEEE Conference Proceedings, European Energy Market EEM12, Florence.

- Ang, J. (2007), "CO<sub>2</sub> emissions, energy consumption, and output in France," *Energy Policy*, vol. 35, pp. 4772-4778.
- Ang, J. (2008), "Economic development, pollutant emissions and energy consumption in Malaysia," *Journal of Policy Modelling*, vol. 30, pp. 271-278.
- Apergis, N. and Payne J.E., (2009), "CO<sub>2</sub> emissions, energy usage and output in Central America," *Energy Economics*, vol. 31, pp. 3282-3286.
- Belloumi, M. (2009), "Energy consumption and GDP in Tunisia: Cointegration and causality analysis," *Energy Policy*, vol. 37, pp. 2745-2753.
- Commission of the European Communities (2008). *Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee of the Regions 20 20 by 2020 Europe's climate change opportunity*. [Online]. Available: [http://www.energy.eu/directives/com2008\\_0030en01.pdf](http://www.energy.eu/directives/com2008_0030en01.pdf)
- Commission of the European Communities (2009). Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC. [Online] Available: <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:32009L0028:EN:NOT>
- Commission of the European Communities (2010). *The EU climate and energy package*. [Online]. Available: [http://ec.europa.eu/clima/policies/package/index\\_en.htm](http://ec.europa.eu/clima/policies/package/index_en.htm)
- Coondoo, D. and Dinda, S. (2002), "Causality between income and emission: a country group-specific econometric analysis," *Ecological Economics*, vol. 40, pp. 351-367.
- De Freitas, L.C. and Kaneko, S. (2011), "Decomposition of CO<sub>2</sub> emissions change from energy consumption in Brazil: Challenges and policy instruments," *Energy Policy*, vol. 39, pp. 1495-1504.
- Dinda, S. (2004), "Environmental Kuznets curves hypothesis: a survey," *Ecological Economics*, 49, pp. 431-455.
- Dinda, S. and Coondoo, D. (2006), "Income and emission: A panel data-based cointegration analysis," *Ecological Economics*, vol. 57, pp. 167-181.
- Energy research Centre of the Netherlands (2003). *Renewable electricity policies in Europe, country fact sheets 2003*. [Online]. Available: <http://www.ecn.nl/docs/library/report/2003/c03071.pdf>
- EurActiv (2011). *Europe's CO<sub>2</sub> emissions growing with the economy*. [Online]. Available: <http://www.euractiv.com/climate-environment/europes-co2-emissions-growing-economy-news-502537>
- European Council (2009) *Climate Change and Energy*. [Online]. Available: [http://www.consilium.europa.eu/uedocs/cmsUpload/Energie-climate\\_change-EN.pdf](http://www.consilium.europa.eu/uedocs/cmsUpload/Energie-climate_change-EN.pdf)
- European Environmental Energy (2004). *Energy subsidies in the European Union: A brief overview*. [Online]. Available: <http://www.eea.europa.eu/>
- European Wind Energy Association (2011). EU Energy Policy to 2050. Achieving 80-95% emissions reduction. [Online]. Available: [http://www.ewea.org/fileadmin/ewea\\_documents/documents/publications/reports/EWEA\\_EU\\_Energy\\_Policy\\_to\\_2050.pdf](http://www.ewea.org/fileadmin/ewea_documents/documents/publications/reports/EWEA_EU_Energy_Policy_to_2050.pdf)
- Eurostat (2011). *Energy Statistics*. [Online]. Available: <http://epp.eurostat.ec.europa.eu/portal/page/portal/energy/introduction>
- Federal Ministry of Economic Affairs and Technology of Germany (2007). *National Energy Efficiency Action Plan (EEAP) of the Federal Republic of Germany*. [Online]. Available: [http://ec.europa.eu/energy/demand/legislation/doc/neeap/germany\\_en.pdf](http://ec.europa.eu/energy/demand/legislation/doc/neeap/germany_en.pdf)
- Federal Ministry for the Environment, Nature Conservation and Nuclear safety of Germany (2011). *Legal sources on renewable energy*. [Online]. Available: <http://www.res-legal.de/en.html>
- Haas, R., Eichhammer, W., Huber, C., Lngniss, O., Lorenzoni, A., Madlener, R. Menanteau, P., Morthorst, P.-E., Martins, A., Onizsk, A., Schleich, J., Smith, A., Vass, Z. and Verbruggen, A. (2004), "How to promote renewable energy systems successfully and effectively", *Energy Policy*, vol. 32, pp. 833-839.
- Halicioglu, F., (2009), "An econometric study of CO<sub>2</sub> emissions, energy consumption, income and foreign trade in Turkey," *Energy Policy*, vol. 37, pp. 1156-1164.
- Held, A., Ragwitz, M. and Haas. R. (2006), "On the success of policy strategies for the promotion of electricity from renewable energy sources in the EU", *Energy & Environment*, vol. 17, pp. 849-868.
- IEA (2011). *CO<sub>2</sub> emissions from fuel combustion*. [Online]. Available: <http://www.iea.org/co2highlights/co2highlights.pdf>



International Feed-in Cooperation (2010) Conclusions of the 8<sup>th</sup> Workshop of the International Feed-in Cooperation. [Online]. Available:

[http://www.google.gr/url?sa=t&rct=j&q=&esrc=s&frm=1&source=web&cd=2&ved=0CFcQFjAB&url=http%3A%2F%2Fwww.feed-in-cooperation.org%2FwDefault\\_7%2Fdownload-files%2F8th-workshop%2FConclusions\\_IFIC\\_Nov2010.pdf&ei=Mzi6T6z7MMmC8gO3\\_5ztCQ&usg=AFQjCNGfZAMHimmmsYLEx5YK2Asx82PL8A&sig2=KcXKNMVUzx5235tvJzAayQ](http://www.google.gr/url?sa=t&rct=j&q=&esrc=s&frm=1&source=web&cd=2&ved=0CFcQFjAB&url=http%3A%2F%2Fwww.feed-in-cooperation.org%2FwDefault_7%2Fdownload-files%2F8th-workshop%2FConclusions_IFIC_Nov2010.pdf&ei=Mzi6T6z7MMmC8gO3_5ztCQ&usg=AFQjCNGfZAMHimmmsYLEx5YK2Asx82PL8A&sig2=KcXKNMVUzx5235tvJzAayQ)

SJacobsson, S., Bergek, A., Finon, D., Lauber, V., Mirchell, C., Toke, D. and Verbruggen, A. (2009), "EU renewable energy support policy: Faith or facts?", *Energy Policy*, vol. 37, pp. 2143-2146.

Jager-Waldau, A., Szabo, M., Scarlat, N. and Monforti\_Ferratio, F. (2011), "Renewable electricity in Europe", *Renewable and Sustainable Energy Reviews*, vol. 15, pp. 3703-3716.

Jaunky, V.C. (2011), "The CO<sub>2</sub> emissions-income nexus: Evidence from rich countries," *Energy Policy*, vol. 39, pp. 1228-1240.

Lauber, V. (2004), "REFIT and RPS: options for a harmonised Community framework", *Energy Policy*, vol. 32, pp. 1405-1414.

Liaskas, K., Mavrotas, G., Mandraka, M. and Diakoulaki, P. (2000), "Decomposition of industrial CO<sub>2</sub> emissions: The case of European Union," *Energy Economics*, vol. 22, pp. 383-394.

Managi S. and Jena, P.R. (2008), "Environmental productivity and Kuznets curve in India," *Ecological Economics*, vol. 65, pp. 432-440.

Marrero, G.A. (2010), "Greenhouse gases emissions, growth and the energy mix in Europe," *Energy Economics*, vol. 32, pp. 1356-1363.

Mehrara, M. (2007), "Energy consumption and economic growth: The case of oil exporting countries," *Energy Policy*, vol. 35, pp. 2939-2945.

Mendoca, M. (2007), "FIT for purpose: 21<sup>st</sup> century policy", *Renewable Energy Sources*, July/August, pp. 60-62.

Meyer, N.I. (2003), "European schemes for promoting renewables in liberalised markets", *Energy Policy*, vol. 31, pp. 665-676.

Narayan, P.K. and B. Singh, B. (2007), "The electricity consumption and GDP nexus for the Fiji islands," *Energy Economics*, vol. 29, pp. 1141-1150.

Narayan, P.K., Narayan, S. and Prasad, A. (2008), "A structural VAR analysis of electricity consumption and real GDP: Evidence from the G& countries," *Energy Policy*, vol. 36, pp. 2765-2769.

Ozturk, I., Aslan A. and Kalyoncu, H. (2010), "Energy consumption and economic growth relationship: Evidence from panel data for low and middle income countries," *Energy Policy*, vol. 38, pp. 4422-4428.

Pao H.-T. and C.-M. Tsai, C.-M. (2010), "CO<sub>2</sub> emissions, energy consumption and economic growth in BRIC countries," *Energy Policy*, vol. 38, pp. 7850-7860.

Ringel M. (2006), "Fostering the use of renewable energies in the European Union: the race between feed-in tariffs and green certificates", *Renewable Energy*, vol. 31, pp. 1-17.

Rowlands I.H. (2005), "Envisaging feed-in-tariffs for solar photovoltaic electricity: European lessons for Canada", *Renewable and Sustainable Energy Reviews*, vol. 9, pp. 51-68.

Soytas, U. and Sari, R. (2009), "Energy consumption, economic growth and carbon emissions: Challenges faced by an EU candidate member," *Ecological Economics*, vol. 68, pp. 1667-1675.

Stern, D.I. (2004), "The rise and fall of the environmental Kuznets curve," *World Development*, vol. 32, pp. 1419-1439.

Tamazian A. and Rao, B.B. (2010), "Do economic, financial and institutional developments matter for environmental degradation? Evidence from transitional economies," *Energy Economics*, vol. 32, pp. 137-145.

U.S. Energy Information Administration (2011). *International Energy statistics*. [Online]. Available: <http://www.eia.gov/cfapps/ipdbproject/IEDIndex3.cfm>

Wolde-Rufael, Y. (2006), "Electricity consumption and economic growth: a time series experience for 17 African countries," *Energy Policy*, vol. 34, pp. 1106-1114.

The World Bank (2007). *Growth and CO<sub>2</sub> emissions: how do different countries fare*. [Online]. Available: [http://www-wds.worldbank.org/servlet/main?menuPK=64187510&pagePK=64193027&piPK=64187937&theSitePK=523679&entityID=000020953\\_20071205142250](http://www-wds.worldbank.org/servlet/main?menuPK=64187510&pagePK=64193027&piPK=64187937&theSitePK=523679&entityID=000020953_20071205142250)

World Resources Institute (2006). *Fossil fuel consumption and its implications*. [Online]. Available: <http://earthtrends.wri.org/updates/node/100>

Zhang, Y.J. (2011), "The impact of financial development on carbon emissions: An empirical analysis in China," *Energy Policy*, vol. 39, pp. 2197-2203, 2011.



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**Low Exergy approach to maintain Indoor Air Quality in tropical buildings**

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Keywords: CO<sub>2</sub>, Emissions, Tropical Climate, Exergy, Indoor Air Quality

**Abstract**

More than a third of the primary energy generated in the world is consumed by buildings for their sustenance using processes like heating, cooling, lighting and other appliances. This primary energy mainly generated by burning of fossil fuels is responsible for a large percentage of global CO<sub>2</sub> emissions and consequently the problem of climate change. The understanding, importance and materialisation of the concept of exergy which focuses on the quality of an energy source could address this problem and mitigate CO<sub>2</sub> emissions. Exergy based building design looks at incorporating Low-Ex systems to specific building processes and optimise energy flow. One way is to separate latent demand from the sensible demand. A system using this concept has been implemented for the heating case in Switzerland, and a similar system is being created in Singapore as a part of the research at Future Cities Laboratory to manage the cooling case.

A traditional air conditioning design employs fixed air changes per hour to remove indoor pollutants of which CO<sub>2</sub> is the most discussed. But if this removal process is performed in a different way i.e. by adsorption or decomposition or another process, the dependence on heavy air changes and the energy associated with it will be reduced. Although some minimum air changes would be required to address issues of other indoor air pollutants. The added advantage is the associated reduction in the dehumidification load which is also critical to the energy consumption of the building.

**Background & Introduction**

Singapore experiences three types of climates all around the year. As Singapore is an island located almost on the equator it experiences a hot and humid climate with usually hot daytimes and unpredictable rains. The winter environment however is experienced inside its buildings. The main reason for this type of a situation is the psychometric process employed to air condition buildings in Singapore. Over cooling is performed to remove humidity from Singapore air, but this process is not coupled with the thermodynamic process of reheating due to regulations, leading to air of 18 °C – 19 °C being blown into the room. This new approach of low exergy building system design could be the answer to achieve higher performances and solve this problem. Exergy basically focuses on the quality of energy and the potential efficiency increase in energy utilization processes. E.g. in a boiler operation.

The energy efficiency increase cannot be quantified but the increase in energy efficiency of the thermodynamic process is close to 100%. The exergy efficiency for the same process however is only about 8% which is comparatively very low. The reason for such a variation is that a large quantity of high quality energy is consumed to produce this low quantity of low quality energy. Exergy can be more clearly understood as the maximum work that can be extracted from an energy flow process primarily caused by the change in the state of systems. The exergy content in the flow expresses the quality of the energy source. Therefore evaluating thermodynamic performances and efficiencies using exergy analysis gives a better and clearer picture. This process largely involves the calculation of exergy of heat and cold, at a temperature below or above the reference temperature of the environment.

The strategy of mixing ventilation is adopted in traditional air conditioning systems. This process works on the concept of dilution of air and its impurities to achieve the space indoor air quality and thermal comfort. Such a system is generally referred to as an overhead air distribution system in the tropics and is usually ducted above a false ceiling. This type of an arrangement therefore demands a higher floor to ceiling height in the building. An under floor air distribution system on the other hand employs the concept of displacement ventilation, achieving thermal comfort through thermal stratification of the surrounding air. This type of a system would also require reduced ceiling to floor height due to the elimination of ducting.

Different leading standards like ASHRAE and Singapore Standard (SS) quote a definite quantity of outside air that must be supplied into the buildings based on the area of the room and the assumed number of people in the room. The aim is to remove indoor air pollutants like CO<sub>2</sub>, VOCs, Bio effluents, dust etc.; CO<sub>2</sub> being the major one. Conditioning Singapore's outdoor air means the employment of high energy consuming processes of dehumidification. To avoid this problem, we look at techniques to remove CO<sub>2</sub> in a more efficient way.

## Methodology

### Exergy

Rant coined the word Exergy and its concept in 1950. It was then used as a tool to optimize thermal power plants [6], but not long ago it has interested engineers to apply the same in the field of sustainable design and building technology [9][11]. Exergy can be better understood as a balance between entropy and energy; combination of the two laws of thermodynamics. It defines in a better way the potential of the system to produce useful work in a specific environmental condition. Exergy quantifies the net potential of a system as influenced by both quantity of energy available and the temperature (quality) available relative to the system's surroundings. [4][5][11]. Energy as such is a combination of two elements; i.e. the exergy and the anergy. In mathematical expression it is  $E = Ex + A$ .

In general cold exergy can be calculated using this equation:

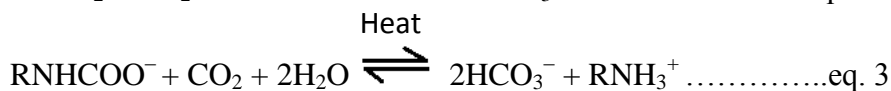
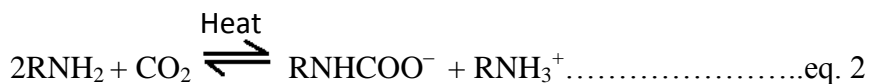
$$Ex = Q \left( 1 - \frac{T_o}{T} \right) \dots \dots \dots \text{eq. 1}$$

Where T<sub>o</sub> is the reference temperature, Q is the energy associated and T is the temperature of the system in observation.

## CO<sub>2</sub> Extraction

Ventilating a space with outside air is done to limit air pollutants like CO<sub>2</sub>, CO, SO<sub>2</sub>, CH<sub>4</sub>, VOCs, dust, biological organisms etc. within their respective threshold levels. The ventilation requirement is developed on this basis. The much discussed and important carbon-di-oxide demands most of the focus among all air impurities and is the cause for large volumes of air changes in ventilation designs. Such large air movements are responsible for major energy consumptions as the outside air needs to be cooled and dehumidified especially in the tropics. This causes a decrease in exergetic efficiency. To overcome this problem we would primarily need to couple ventilation requirement to the dynamic occupancy of the space. We would then need to look at more novel techniques like absorption or adsorption or dissolution etc. to remove the impurities or CO<sub>2</sub>. By employing such a methodology the chance of reducing the outdoor air intake would significantly increase. Our focus can then be on removing the other pollutants like VOCs, Methane, Formaldehyde, bio effluents, dust etc. which could have a smaller impact on the overall outdoor air requirement to ventilate the space hence reducing primary energy use and increasing exergetic efficiency without compromising indoor air quality. Some such technologies have been used in the past but never in the building domain. The use of Scrubbers in submarines, solid oxide fuel cells in space crafts or chemical adsorbent based systems is an area of high level research. A solid fuel cell based system could have a CO<sub>2</sub> reduction potential of more than 30% compared to the conventional system [8]. This process converts chemical energy released from the reaction of air and a fuel mixture into electrical energy. Electro chemical reduction of oxygen molecules at the cathode of the fuel cell cause oxygen to diffuse and produce on the anode. These oxygen ions then react with the fuel and release electrons which circulate through an electrical circuit providing the gaseous product of the reaction.

CO<sub>2</sub> scrubber technology has been extensively used in submarine operations and ventilation requirements since world-war 2. As submarines have to be under water for a long period of time, it becomes more important to concentrate our effort on indoor air quality. One of the processes used in scrubbers is the use of Mon ethanolamine (popularly called MEA), which can reduce the CO<sub>2</sub> levels in submarines to 0.5% or even as low as 0.2% of the pressure, which is within the safe levels; British findings proclaiming a continuous exposure to 1% pressure of CO<sub>2</sub> can change the p<sup>H</sup> of blood and interfere with the body's ability to retain essential metabolic salts [7]. The chemical property in amine solutions to absorb and desorb CO<sub>2</sub> could be a possible solution to remove CO<sub>2</sub>. The plant's operations is based on the ability of cool amine solution to readily absorb CO<sub>2</sub>, while the hot amine solution gives up most of its CO<sub>2</sub> content. The amine solution used in the scrubber consists of water, a chelating agent and monoethanolamine, HO – CH<sub>2</sub> – CH<sub>2</sub> – NH<sub>2</sub>. When CO<sub>2</sub> is absorbed or desorbed in aqueous MEA solution two reactions takes place [3]



where R is HOCH<sub>2</sub>– CH<sub>2</sub>.

The MEA solution with higher CO<sub>2</sub> content is referred to as rich MEA solution and the solution containing lower amounts of CO<sub>2</sub> is referred to as lean MEA solution.

The property of CaO to absorb and desorb CO<sub>2</sub> is another area of investigation. Standard humid calcium oxide absorbs CO<sub>2</sub> and produces CaCO<sub>3</sub> as a by-product in an exothermic chemical reaction  $\text{CaO} + \text{CO}_2 \rightarrow \text{CaCO}_3$ . If this heat is tapped, it can be used for other heating purposes or can also be redirected to act as reheat in the dehumidifying and conditioning process of the incoming air. The CaO can then be regenerated in an endothermic process later. The endothermic reaction is  $\text{CaCO}_3 \rightarrow \text{CaO} + \text{CO}_2$  which is also the regeneration process [1].

In another enzyme based CO<sub>2</sub> extraction process employed by NASA, an enzyme based liquid membrane bioreactor is designed for CO<sub>2</sub> capture. The concept of selectivity for CO<sub>2</sub> is high for particular enzyme quantities i.e. 1400:1 for CO<sub>2</sub> v/s N<sub>2</sub> and 866:1 for CO<sub>2</sub> v/s O<sub>2</sub> [13]. This is a high selectivity function and can act as a good approach to extract CO<sub>2</sub>. NASA has already tested this type of a reaction based CO<sub>2</sub> removal process in a 180 day spacecraft prototype where the measured values of CO<sub>2</sub> was 0.307kPa of pressure, the upper limit being 1.067 kPa as a safe concentration [13], but NASA's own maximum allowable concentration being 0.709 kPa [12]. The American Society of Heating, Refrigerating, and Air Conditioning Engineers, ASHRAE, reports that people complain of stuffy air at CO<sub>2</sub> concentrations of 0.101 kPa [2].

## Results and discussion

An experimental laboratory called Bubble ZERO (Zero Emission Research Operation) was setup in September 2011 in Singapore using two combined together twenty feet containers. This lab will be used to study the low exergy system consisting of radiant panels, decentralized ventilation systems and a customised chiller's operation in Singapore. The laboratory represents a work space of 6 m x 5 m x 2.8m. This project was started through collaboration between ETH, Zurich and National Research Foundation, Singapore in Future Cities Laboratory, Singapore. It is aimed to look at adaptation techniques and use of Low-Ex building systems already incorporated in Zurich to achieve enhanced conditioning of air and thermal comfort in Singapore.

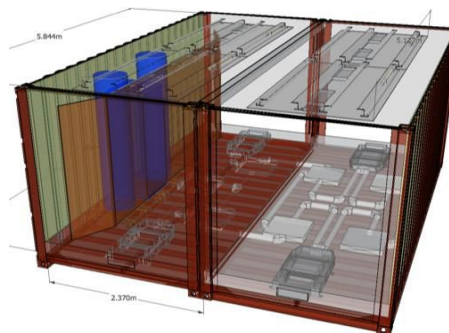


Fig 1: Bubble ZERO Research Lab Schematic

The present basis for designing ventilation requirements is by following a simple mass balance of air equation [14]

$$V_o = \frac{N}{C_s - C_o} \dots \dots \dots \text{eq. 4}$$

Where  $V_o$  = outdoor air flow rate per person;

$N$  = CO<sub>2</sub> generation rate per person;

Cs = CO<sub>2</sub> concentration in the space;  
 C<sub>o</sub> = CO<sub>2</sub> concentration in outdoor air.

In the present design formula, the dynamic nature of occupancy is not registered. Also the focus is only on the mass balance of CO<sub>2</sub>. It is very important that the volumetric balance of the gases is considered. As outdoor air has a fixed amount of CO<sub>2</sub> already present in it, the room CO<sub>2</sub> level is only affected by the occupant's input of CO<sub>2</sub>. This leads to the formulation of a differential equation in order to study the relationship between mass balance and the volumetric balance based on occupancy dynamism. Considering the mass balance of CO<sub>2</sub> flow we have a generalized partial differential equation:

$$\left(\frac{dv}{dt}\right)_{\text{out}} \cdot \left(\frac{dm}{dv}\right)_{\text{out}} + \left(\frac{dN}{dt}\right)_{\text{person}} \cdot \left(\frac{dm}{dN}\right)_{\text{person}} - \left(\frac{dv}{dt}\right)_{\text{ext}} \cdot \left(\frac{dm}{dv}\right)_{\text{ext}} = \left(\frac{dm}{dt}\right)_{\text{tot}} \dots \dots \dots \text{eq.5}$$

where the subscript “out” represents the property in outdoor air (the volumetric variation and density), subscript “person” represents the amount of CO<sub>2</sub> exhaled by people. The term  $\frac{dN}{dt}$  represents the variation in the number of people with time and  $\frac{dm}{dN}$  represents the variation in the amount of CO<sub>2</sub> with occupancy. If we incorporate the approach of adsorption or absorption of CO<sub>2</sub> in this process we come up with a third parameter which has to be subtracted from the initial equation as it is removed by this process. That is the amount measured in the exhaust or the safe limit for operation.  $\frac{dv}{dt}_{\text{ext}}$  and  $\frac{dm}{dv}_{\text{ext}}$  would represent the volume of air sample monitored in a time interval and the amount of CO<sub>2</sub> that is present in that sampling volume respectively. If we need to maintain the CO<sub>2</sub> within prescribed limits, the CO<sub>2</sub> removal process will only happen when this criteria is satisfied;

$$\left(\frac{dm}{dv}\right)_{\text{room}} > \left(\frac{dm}{dv}\right)_{\text{ext}} \dots \dots \dots \text{eq. 6}$$

or when the amount of CO<sub>2</sub> in the room exceeds the CO<sub>2</sub> level in the exhaust channel. And the rate of CO<sub>2</sub> removal is determined by this equation.

$$\left(\frac{dm}{dv}\right)_{\text{room}} \cdot \left(\frac{dv}{dt}\right)_{\text{ext}} - \left(\frac{dm}{dv}\right)_{\text{out}} \cdot \left(\frac{dv}{dt}\right)_{\text{out}} \dots \dots \dots \text{eq. 7}$$

When we look into the overall density of CO<sub>2</sub> in the space, we can represent it in such an equation

$$\left(\frac{dm}{dv}\right)_{\text{room}} = \left(\frac{dm}{dv}\right)_{\text{out}} + RQ \cdot \left(\frac{dm}{dN}\right) \cdot N / V \dots \dots \dots \text{eq. 8}$$

N: number of people in the room and V is the volume of the room ( $\text{m}^3$ )

where the density of  $\text{CO}_2$  in the room is dependent on the density of  $\text{CO}_2$  from outside air which is usually constant and the variation in the occupancy density and its associated  $\text{CO}_2$  mass. The term RQ would represent the respiratory co-efficient which is the volumetric ratio of  $\text{CO}_2$  produced to oxygen consumed.

$\text{CO}_2$  extraction mechanisms will be investigated in greater detail during the course of my PhD to get quantifiable data. The impact, reducing outdoor air intake and in turn energy consumption with the employment of such an adsorber or absorber system will be studied. As some studies show the influence air movement in a room may have on enhancing thermal comfort. The incorporation of such a system will have an associated decrease in air flow. So the impact of such a process on thermal sensation and thermal comfort will also be studied. CFD analysis will be performed further to see how the movement of  $\text{CO}_2$  and  $\text{H}_2\text{O}$  takes place inside the space and how it influences air flow.

## Conclusion

Maintaining indoor air quality of a space is very essential but there can be better ways of achieving the same using lesser energy and efficient processes. Considering dynamic occupant density, volumetric  $\text{CO}_2$  variations and relationships between mass flow rate of  $\text{CO}_2$  and density flows of  $\text{CO}_2$ , we can optimize the ventilation design process to a greater extent. Associated problems of low air movements, replenishment of adsorption or absorption materials and affinity of the gases towards the adsorption process are things that need more investigation. Such a process can also better control mechanisms. Coupling such a  $\text{CO}_2$  removal mechanism with other low exergy technologies like the decentralized ventilation and radiant cooling systems can reduce further the energy consumption of the building and increasing exergetic efficiency which directly translates into enhanced performance. The successful use of this technique in other domains brings hope that this type of a process can also be incorporated into the building domain. It is though important to study what impact this process will have on other air impurities present in the room and how the reduction in outdoor air flow affects the removal of these impurities like VOCs, Methane, CO,  $\text{SO}_2$ , biological impurities, dust etc. It is also important that the impact on thermal comfort is unaffected. We anticipate further analysis and tests to be conducted in our research laboratory Bubble ZERO. Our goal is to continue to reduce the primary energy demand for operation such that the supply of renewable energy can meet the demand economically, and to achieve our overall goal of zero emission operations.

## References

1. A. Corrado, P. Fiorini, E. Sciubba, Environmental assessment and extended exergy analysis of a zero  $\text{CO}_2$  emission, high-efficiency steam power plant, Energy, Vol. 31, 2006
2. American Society of Heating, Refrigerating, and Air Conditioning Engineers. 2001 ASHRAE Fundamentals Handbook. Atlanta: ASHRAE. 2001. Chapter 9
3. Astarita, G.,  $\text{CO}_2$  absorption in amine solutions, Mass transfer with chemical reaction, Elseviers, 1967
4. Bejan A. Advanced engineering thermodynamics. 3rd ed., vol. XL. Hoboken; John Wiley & Sons; 2006



5. Borel, L. and D. Favrat , Thermodynamics and energy systems analysis from energy to exergy. Lausanne, EPFL Press, 2010
6. Brodyansky, V. M., The efficiency of industrial processes: exergy analysis and optimization. Amsterdam etc., 1994, Elsevier
7. Carey, Gomezplata, Sarich, Ocean Engng, Submarine CO<sub>2</sub> scrubber development, Vol 10, No 4, 1983
8. Ce´line Weber, Michihisa Koyama, Steven Kraines, CO<sub>2</sub>-emissions reduction potential and costs of a decentralized energy system for providing electricity, cooling and heating in an office-building in Tokyo, Energy, Vol. 31, 2006
9. Cornelissen, R. L., Thermodynamics and Sustainable Development: The Use of Exergy Analysis and the Reduction of Irreversibility. PhD Doctoral, University of Twente, 1997
10. Dietrich Schmidt, Low exergy systems for high-performance buildings and communities, Vol. 41, Energy and Buildings, 2008
11. Dincer, I. and M. Rosen, Exergy : energy, environment, and sustainable development. Amsterdam ; Boston, 2007, Elsevier
12. Drysdale, A.E. and Hanford, A.J, Advanced life support systems modelling and analysis project baseline values and assumptions document, Technical Memorandum, Document number CTSD – ADV – 371, NASA Johnson Space Center, Houston, TX, 1999
13. J.-J. Ge, R. M. Cowan<sup>2</sup>, C.-K. Tu<sup>3</sup>, M. L. McGregor<sup>1</sup>, M. C. Trachtenberg, Enzyme Based CO<sub>2</sub> capture for advanced life support, NASA
14. American Society of Heating, Refrigerating, and Air Conditioning Engineers. ASHRAE Std. 62.1, Atlanta, 2007

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**REGULATED AND VOLUNTARY CARBON MARKET PROJECTS: STATUS AND CONTRIBUTION TO GHG EMISSION REDUCTION IN BRAZIL**

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Number and title of the track: 2c - climate change adaptation in the context of sustainable development

Preferred form of presentation: oral

**Abstract**

The global climate change governance encourages the use of market mechanisms to facilitate the industrialized countries to comply with the GHG<sup>1</sup> emission reduction targets established by the Kyoto Protocol. Among these mechanisms, the first one is the regulated carbon market, which enables industrialized countries to reach their mandatory GHG emission reduction targets through Clean Development Mechanism (CDM) projects implemented in developing countries. The second one is the voluntary carbon market, which works outside the Kyoto Protocol regulation in order to help countries without legally binding targets to fulfill with their non-mandatory GHG emission reduction goals.

Brazil doesn't have any mandatory GHG emission reduction target, but it committed itself to voluntarily reducing its emissions between 36.1%-38.9% by 2020 and it is one

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<sup>1</sup> Gases such as: carbon dioxide (CO<sub>2</sub>), methane (CH<sub>4</sub>), nitrous oxide (N<sub>2</sub>O) and hydrofluorocarbons (HFCs). They have different Global Warming Potentials (GWP), which is measured relative to the warming potential of CO<sub>2</sub>. Thus, for example, the GWP of CH<sub>4</sub> is 23 tonnes of CO<sub>2</sub> equivalent (CO<sub>2</sub>e) per tonne of CH<sub>4</sub>, and the GWP of N<sub>2</sub>O is 296 tonnes CO<sub>2</sub>e/tonnes N<sub>2</sub>O.

of the most successful developing countries for hosting regulated and voluntary carbon market projects in the world.

Assuming that one of the main objectives of carbon market projects is to decrease the GHG emissions and promote sustainable development, this paper was built upon the following research question: what is the current status of the project activities under the regulated and voluntary carbon markets in Brazil and their contribution to national GHG emission reduction? Thus, this research evaluates the status and the contribution of regulated and voluntary carbon markets projects to GHG emission reduction in Brazil. To achieve this goal, an empirical database was built with secondary data collected from Project Design Documents (PDD) of 610 carbon market projects under validation/approval process in Brazil by June 30, 2011. A documentary content analysis technique was used to acquire secondary data from the PDD's. The methodology and results presented in this exploratory paper are part of the preliminary findings of a work-in-progress research project entitled "Brazil's Participation in International Carbon Market: a comparative analysis between regulated and voluntary markets", sponsored by Brazil's National Council for Scientific and Technological Development (CNPq). The results of this study show the prevalence of the number of the regulated carbon market projects (82%) as compared to the voluntary carbon market ones (18%).

In relation to the regional distribution of these projects in the country, the Southeastern region concentrate the majority of regulated and voluntary carbon market projects, especially because of the industrialized state of São Paulo, with 37% and 43% respectively. In Brazil, the regulated carbon market projects contribute to 65.37% of the expected annual GHG emission reductions by 2020, whereas the voluntary ones respond to only 3.60%.

Regarding the type of GHG reduced by carbon market project activities in Brazil, it can be noted that the carbon dioxide (CO<sub>2</sub>) is currently the most relevant in both regulated and voluntary markets (67% and 59% respectively), followed by methane (CH<sub>4</sub>) and nitrous oxide (N<sub>2</sub>O). In relation to the distribution of carbon market project activities by sectoral scope, the majority of these projects developed in Brazil is in the energy sector: using renewable energy with 52.3% in the regulated market and replacing deforestation biomass fuel by planted-forest one with 32% in the voluntary market. It explains why CO<sub>2</sub> is preponderant in the Brazilian emission reduction.

Concerning the scale of the Brazilian carbon market projects, it was found that, in the regulated market, most of them are large scale (58%), whereas in the voluntary market,

most are small-scale projects (88%). In relation to the contribution of the regulated carbon market project activities in Brazil to the GHG emission reduction, the results show that the types of projects that reduce more tons of CO<sub>2</sub>e are landfill, renewable energy generation and reduction of N<sub>2</sub>O, representing 76% of the annual emission reduction in this market. Moreover, in the voluntary market, the use of renewable energy, the replacing of deforestation biomass fuel by planted-forest one and the reforestation projects are responsible for 74% of the annual GHG emission reductions. Regarding the total installed capacity of these energy generation projects, it was found that the regulated and voluntary carbon market projects contribute to increasing the capacity for renewable power generation in Brazil. Whereas the regulated market projects contribute to the generation of 4,032 MW, the voluntary market projects contribute to 1,229 MW. The big and small hydropower plants are responsible for 61% of renewable power generation in the regulated market and 99% in the voluntary one.

In conclusion, this paper defends that the regulated and voluntary carbon market projects make a significant contribution to GHG emission reduction in Brazil. This preliminary conclusion, however, could be biased by the fact that no on-ground examination was implemented. The next phase for this work-in-progress research contemplates the combination of PDD assessment with case studies in order to evaluate the contribution of these carbon markets to reducing GHG emissions and to promoting cleaner technologies and sustainable development in Brazil. Finally, it is recommended that future studies compare the Brazilian experience to that of the other two main regulated and voluntary carbon market projects host countries in the world, China and India.

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**Expert Views of Climate Change Adaptation in Least Developed Asia**

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**Abstract:** Drawing primarily from original data collected from more than 100 semi-structured expert research interviews, this study discusses the benefits of four climate change adaptation projects being implemented in Bangladesh, Bhutan, Cambodia, and the Maldives. The article begins by explaining its research methods and selecting a sample of Global Environment Facility-Least Developed Country Fund projects being implemented in Asia. It then describes ongoing adaptation efforts in each of these four countries. It finds that projects enhance infrastructural resilience by building relevant, robust, and flexible technologies. They build institutional resilience by creating strong, permanent, legitimate organizations in place to respond to climate change issues. They promote community resilience by enhancing local ownership, building capacity, and creating networks that help ordinary people learn and adapt to climate change. We find that all four of our case studies couple adaptive improvements in technology and infrastructure with those in governance and community welfare, underscoring the holistic or systemic aspect of resilience. Our study also demonstrates the salience of a functions-based approach to resilience and adaptive capacity rather than an asset-based one.

**Keywords:** Climate change adaptation; resilience; adaptive capacity; Asia; least developed countries

**Expert Views of Climate Change Adaptation in Least Developed Asia**

**1. Introduction and Aims**

This study discusses the resilience benefits of climate change adaptation projects being implemented in Asia under the Global Environment Facility's (GEF) Least Developed Countries Fund (LDCF) from the perspective of a select group of experts. Established in 2001, the LDCF was created exclusively to help least developed countries prepare and implement national adaptation programs of action aimed at improving adaptive capacity related to climate change. Currently one of the world's largest funds for climate adaptation, the GEF has so far (as of July 2011) leveraged \$415 million in voluntary contributions to support 47 adaptation projects in 48 countries, projects implemented in tandem with partner agencies including the World Bank, United Nations Development Program, and Food and Agriculture Organization.

This article specifically asks: what forms of adaptation are currently ongoing in four least developed Asian countries, and what does this tell us about building community, infrastructural, and institutional resilience to the consequences of climate change? In answering this question, the article begins by explaining its research methods and how a sample of LDCF projects being implemented in Asia was selected. It then describes four ongoing climate change adaptation efforts in Bangladesh, Bhutan, Cambodia, and the Maldives before proposing that successful programs and policies cut across multiple dimensions. They strengthen infrastructural resilience by creating or rehabilitating relevant, robust, and flexible technologies. They promote institutional resilience by bolstering strong, permanent, legitimate organizations in place to respond to climate change issues. They encourage community resilience by enhancing local ownership over assets, building capacity, and creating networks that help ordinary people learn and adapt to climate change.

The project's research is unique in at least three senses. First is its comparative focus on adaptation rather than climate change mitigation in the four countries studied (Bangladesh, Bhutan, Cambodia, and the Maldives). Adaptation efforts are necessary if communities are to respond to drastic changes in climate once tipping points, such as acidification of ocean, alteration of the Gulf Stream, or thawing permafrost, are crossed, and adaptation can also have a high relevance regarding slow or gradual changes in climate (Victor et al. 2009; Jerneck and Olsson 2008). Furthermore, adaptation efforts tend to be "win-win situations," for they not only improve resilience to climate change but often spillover into ancillary benefits such as economic stability, improved environmental quality, community investment, and local employment (Wilbanks et al. 2007; Economics of Climate Adaptation Working Group 2009; Ayers and Forsyth 2009; Ostrom 2010; Sovacool 2011). The Asian Development Bank (2009) estimates that every \$1 invested in adaptation now could yield as much as \$40 in economic benefits by 2030. Yet despite the importance of adaptation, developed countries spent only \$40 million in 2007 on adaptation measures in the world's poorest regions yet expended billions of dollars in mitigation and technology and infrastructure to prepare their own countries (Prouty 2009).

Second, the study moves beyond vulnerability mapping to actually assess the effects of current adaptation efforts. Much policy research related to adaptation centers on providing credible estimates of adaptation costs, or conducting vulnerability assessments, or trying to guide future adaptation strategies at the sectoral or national level (Ayers and Forsythe 2009; Gibbs 2009; McDaniels et al. 2008; Mahoney 2000). As one example, the Economics of Climate Adaptation Working Group (2009), an interdisciplinary collection of experts from the GEF, insurance agencies, consulting firms, civil society, and academic experts, assessed the costs and benefits of adaptation among a sample of developing and developed countries. They calculated

that the most cost-effective adaptations in the agricultural sector in cases such as China or Mali were better irrigation control or improved fertilizer use, whereas in Florida it was beach nourishment, floodwalls, and roof strengthening. In India drip irrigation yielded the most benefits, while in other places ground water pumping, canal lining, or crop engineering options should be prioritized. These different options can be expressed in a cost-benefit assessment, or “cost curve,” that plots the most cost effective options from left to right, with the least effective on the right (See Figure 1). We chose Florida as an example for Figure 1 because it had one of the most diverse sets of adaptation options reported by the study.

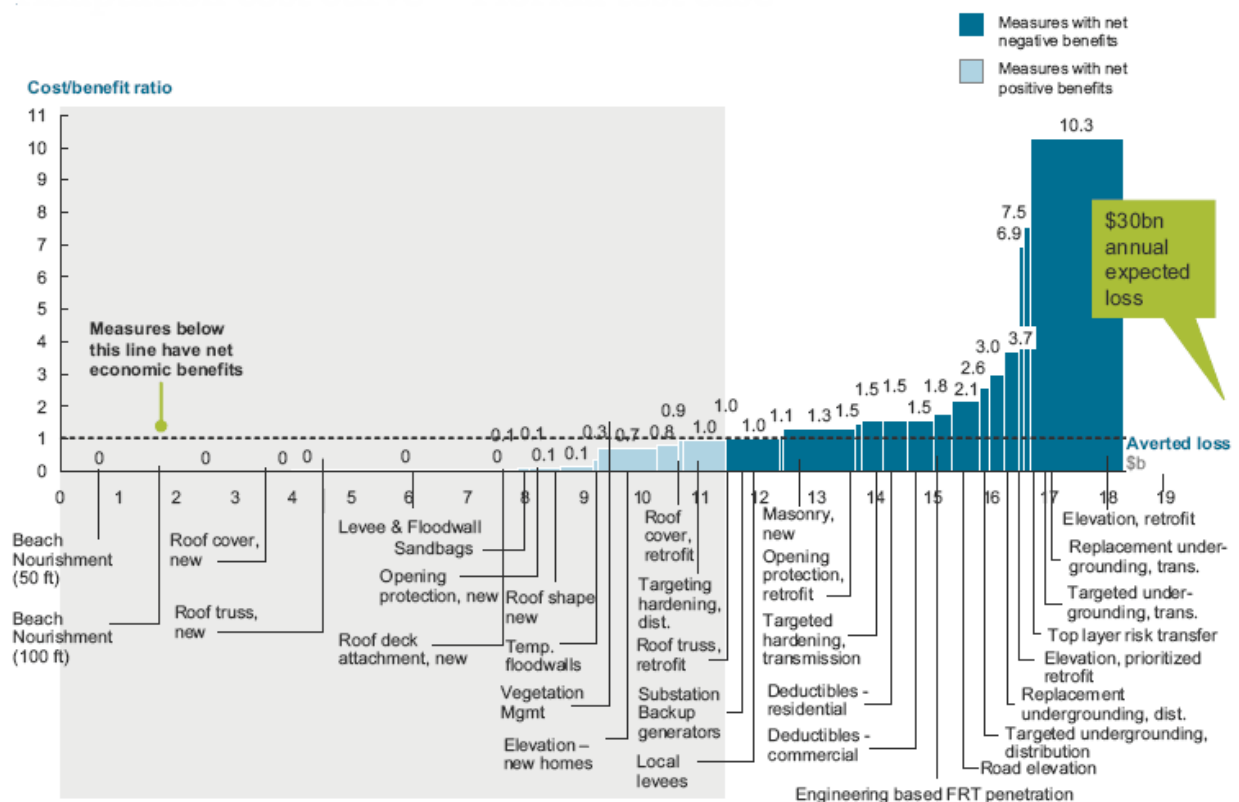


Figure 1: Adaptation Cost Curve for Florida

Source: Modified from Economics of Climate Adaptation Working Group 2009.



In essence, these studies investigate where adaptation money should go and who should adapt. This article looks instead at how effective existing adaptation efforts have been, or how well the money has been spent. Table 1 shows a diverse array of 70 possible adaptation efforts and measures. In the face of rising sea levels, for instance, policymakers and planners could build sea walls and dykes, afforest coastal areas, or relocate coastal communities further inland. Currently, not much research actually investigates adaptation projects that are in the process of being implemented around the world. Such assessment is essential if policymakers and even scholars are to prioritize the adaptation efforts that work best at accomplishing adaptation goals.

**Table 1: Sample of Seventy Climate Change Adaptation Efforts (By Sector)**

<i>Deteriorating Human Health</i>	Improving health or sanitation standards
	Vaccinations
	Imposition of air quality standards
	Training of medical staff
	Informing vulnerable groups
<i>Deforestation</i>	Fire prevention
	Introduction of new species
	Changing cutting practices
	Sustainable forest use quotas
<i>Lack of Water Availability</i>	Changing location or height of water intakes
	Installing canal linings
	Using closed conduits instead of open channels
	Integrating separate reservoirs into a single system
	Using artificial recharge to reduce evaporation
	Raising dam heights
	Building desalination plants
	Increasing canal size
	Removing sediment from reservoirs

	Build and expand cisterns, floodplain setbacks, and levies
	Interregional or interbasin water transfers
	Formulation of water efficiency standards
	Recycling water
<i>Sea level rise</i>	Planting mangroves and coastal afforestation
	Coastal land acquisition
	Building storm surge barriers
	Building bridges
	Erecting seawalls
	Incentivizing development away from coastal areas and bluffs
	Coral reef propagation
	Beach nourishment
	Dykes
	Conversion of farms to fish ponds and aquaculture
<i>Agriculture and drought</i>	Expanding rainwater harvesting
	Adjusting planting dates and crop variety
	Developing drought resistant crops
	Promotion of dry-farming techniques such as seeding and minimum tillage
	Building reservoirs
	Improving fertilizer use
	Expand the use of waste methane for energy production
	Grazing land management
	Restoring cultivated organic soils
	Restoring degraded lands
	Rice management
	Livestock management
	Manure management
	Improving irrigation
	Crop insurance

	Emergency plans for famines
<i>Extreme temperatures</i>	Opening of cooling centers
	Promotion of deciduous shading
<i>Severe storms</i>	Strengthening buildings against storms
	Extending the amount of rainfall or the temperature infrastructure can withstand
<i>Permafrost melt</i>	Establishing glacial flood control mechanisms
	Building dams
	Insulating railway lines
<i>Ecosystem adaptation</i>	Species transplantation
	Maintaining biodiversity gene banks
	Improved pest management
	Removing barriers to the migration of plants and animals
	Maintain healthy vegetation on slopes
<i>Informational infrastructure</i>	Environmental monitoring
	Weather forecasting
	Seasonal crop forecasting
	Early warning systems
	Analysis of saline front changes
	Monitoring coastal erosion
	Disease and epidemiological tracking
	Awareness campaigns
<i>Institutional infrastructure</i>	Land use planning
<i>Risk transfer</i>	Various other insurance measures

108 Source: Brown and Sovacool 2011; Archer and Rahmstorf 2010; Peake and Smith 2009.

109 Third, this study focuses on least developed countries. These countries often lack the  
110 requisite capacity to implement adaptation projects. While the city of Perth in Western Australia  
111 can build a desalination plant to offset losses in water due to declining precipitation and  
112 increasing drought; planners in the Netherlands can construct dikes, dams, and floating houses to

cope with increased flooding and rises in sea level; and London can invest in a Thames River barrier system to better respond to floods (Rockefeller Foundation 2010), some of the world's poorest areas have no resources to implement adaptation projects on their own. Least developed countries depend on climate sensitive sectors such as agriculture, tourism, and forestry, meaning that they are affected directly and significantly by changes in temperature and precipitation and extreme weather events. Yet 75 to 250 million people in Africa are expected to be exposed to increased water stress by 2020, and yields from rain-fed farms and agricultural sectors could fall by up to 50 percent (Prouty 2009). In addition, developing countries tend to lack resources such as advanced health care and transportation systems that leave them at greater risk of adverse impacts. They are also, for a variety of geographic and economic reasons, located in regions at the greatest risk of rising sea levels, deteriorating ecosystem services, social tensions, and the creation of environmental refugees (Sovacool 2009).

## 2. Methods

The authors first selected a sample of LDCF projects to review. For the sake of simplicity and proximity to their own institution, the authors chose to examine all four projects currently being implemented by the LDCF in Asia. These include adaptive efforts related to coastal afforestation in Bangladesh, glacial flood control in Bhutan, coastal protection in the Maldives, and agricultural innovation in Cambodia. Table 2 provides an overview of these efforts.

**Table 2: Overview of LDCF Case Studies in Asia**

Sector/Type of Adaptation	Country	Budget	Duration	Primary Actors	Description
Coastal Afforestation	Bangladesh	\$10.8 million	March 2009 to February 2013	United Nations Development Program; Forest Department at the Ministry of Environment and Forest	Utilizes community-based afforestation, mangrove regeneration and plantation management, erosion prevention, and the deployment of coastal sediment barriers to

					reduce climate-vulnerabilities in four upazilas in the coastal districts of Barguna, Patuakhali, Bhola, Noakhali, and Chittagong
Glacial Flood Control and Early Warning Systems	Bhutan	\$8.3 million	March 2008 to February 2013	United Nations Development Program; Department of Geology and Mines at the Ministry of Economic Affairs; Disaster Management Division of the Ministry of Home and Cultural Affairs	Implements a disaster management plan and will demonstrate technologies available to reduce glacial lake outburst floods from the Thorthormi glacial lake in the Punakha-Wandgi Valley and Chamkhar Valleys
Coastal Protection	Maldives	\$9 million	March 2010 to February 2013	United Nations Development Program; Ministry of Environment, Energy, and Water	Establishes a climate information system to collect and disseminate knowledge about climate vulnerability and designs a migration plan of Safer Islands where at threat communities can relocate to
Agriculture	Cambodia	\$4.4 million	July 2009 to June 2013	United Nations Development Program; Ministry of Agriculture, Fisheries and Forestry; Ministry of Water Resources and Meteorology	Trains engineers in climate-resilient irrigation design (including reservoirs, irrigation canals, ponds, and dykes) and establishes a community-based climate information system on floods and droughts

To collect information on these cases, the authors relied on expert interviews as our primary tool for data collection. The authors developed interview questions through two intensive focus group discussions with ten experts in public policy and research methodology in March and April 2010. Interview questions were also pretested with colleagues at the authors' institutions, and questions were broad and open-ended to enable participants to provide detailed answers. An interview protocol was designed which included asking participants to (a) identify the most serious climate change related concerns facing communities in each country, (b) summarize ongoing adaptation efforts related to the LDCF fund, and (c) explicate expected costs and benefits for those efforts. The lead author and his research team proceeded to conduct 109 of these research interviews with 50 institutions and communities in 26 locations in 7 countries (some home to the headquarters of key stakeholders) over the course of May 2010 to October

2010, during research trips summarized in Appendix I. In each case we had simultaneous real time translation into local languages and dialects. We relied on a purposive sampling strategy to select participants, meaning experts were chosen to represent different aspects of the cases in question. We also adhered to a critical stakeholder analysis framework that required us to include a broad spectrum of respondents from government, civil society, business, academia, and local communities. Due to Institutional Review Board guidelines at the National University of Singapore, as well as the request of some participants, we present such data in our article as anonymous, though information from the interviews was often recorded and always carefully coded. These interviews were supplemented with site visits to more than a dozen communities (with at least 3 visited for each case study) where the lead author and his team spoke with more than 100 villagers about adaptation projects.

The study relied on semi-structured, expert interviewing as its major research tool for many reasons. One is that little secondary data on LDCF adaptation efforts in the four countries chosen for analysis were available, with the exceptions of Meenawat et al. (2011), D'Agostino et al. (2011), and Rawlani et al. (2011), although these latter works focus only on national efforts, and do not provide comparative analyses.

Another reason is that qualitative methods such as in-depth research interviews and field research are most useful when the research objective is to understand complex factors that are irreducible to a few key variables (Drumwright and Murphy 2004), as was the case with ongoing adaptation efforts in Asian countries. Expert interviews refer to those that are targeted at specialists, or those implementing policies and making decisions, as opposed to general consumers or voters (Dexter 1970). Expert interviews are intended to help researchers understand how policymakers or decision makers view a particular problem, and the authors

targeted them for this study because they are the ones making (or influencing) adaptation decisions in the countries selected. Perhaps counter intuitively, such interviews also enabled us to collect data from groups difficult to access as well. Many of the key stakeholders involved in adaptation efforts, such as community leaders or farmers, were either illiterate or did not speak English, necessitating the use of non-textual forms of data collection.

Finally, we felt the qualitative, open-ended nature of the interviews could best capture the complexities and accurately describe adaptation efforts in Asia. Adger et al. (2003) have noted, for example, that successful adaptation projects involve an interdependence of complex factors that cut across institutional and technological domains, as well as geographic scales and academic disciplines. Adger et al. (2005) further write that assessing the effectiveness of adaptation can be difficult to measure, since it depends on more elusive variables such as the sequence and interaction of complicated historical events and also relates to the concepts of efficiency, equity, and values which are hard to boil down quantitatively. Moreover, D'Agostino et al. (2011), Meenawat et al. (2011), Bunce et al. (2010), Osbahr et al. (2010), Doria et al. (2009), and Few (2007), to name a few, have demonstrated the utility of qualitative methods in describing or evaluating climate change adaptation in other developing countries and sectors.

### 3. Results

Drawn mostly from the original data collected through our expert interviews, this section of the paper focuses on the benefits respondents identified related to four ongoing adaptation efforts in Asia: coastal afforestation in Bangladesh, glacial flood control in Bhutan, agricultural production in Cambodia, and community relocation in the Maldives. Before we elaborate on our results, it is first necessary to briefly describe each adaptation program.

In Bangladesh, the Ministry of Environment and Forests is aiming to reduce the vulnerability of coastal communities to the impacts of climate change by carrying out afforestation in four *upazilas* (translated as sub-districts) in the coastal districts of Barguna and Patuakhali (Western region), Chittagong (Eastern Region), Bhola (Central Region) and Noakhali (Central Region). Project managers selected sites on the basis of their projected vulnerability and also through public participation. The project has four primary components. The first is implementing interventions that generate income and couple afforestation with community livelihood. The second is enhancing national, sub-national, and local capacities of government authorities and sectoral planners so that they better comprehend climate risk dynamics in coastal areas and implement appropriate risk reduction measures. The third is reviewing and revising coastal management practices and policies. The fourth is developing a functional system for the collection, distribution and internalization of climate change related data.

In Bhutan, the government launched the Glacial Lake Outburst Flood (GLOF) project to tackle disaster risks. It has three primary components. A component focused on lowering of lake water levels is being undertaken by the Department of Geology and Mines (DGM) to reduce the risk of GLOFs at two glacial sites in the Himalayas. So far mitigation work by DGM has focused only on one lake, Thorthormi, where it is aiming to reducing the lower lake's water level by five meters, enough to eliminate hydrostatic pressure on its unstable moraine dam. An early warning component is being led by the Department of Energy, and a third community awareness component is attempting to increase the knowledge of climate change among community leaders and policymakers.

In Cambodia, planners are focusing on building adaptive capacity for water management and agriculture. The primary objective of their project is to enhance the ability of local



government and communities to integrate long-term climate risks into policy and decision-making related to subsistence farming and rice paddy production. Many of the communities living in the targeted districts in Preah Vihear and Kratie practice subsistence farming and are therefore reliant on agriculture for their livelihoods. Adaptation efforts are focusing on educating these farmers and local leaders about climate change, and also strengthening infrastructure such as irrigation channels and ponds.

The Maldivian government is integrating climate change risk and management into formal planning processes. Their adaptation project is funding demonstration projects on four islands that promote a suite of different infrastructural improvements including beach nourishment, coral reef propagation, land reclamation, and possible community relocation. The project is also creating “composite risk reduction plans” to be integrated with coastal protection and adaptation measures. Disaster risk profiles are to be created for the four demonstration islands, revised and updated as scientific knowledge about climate change and sea level rise accumulates. These are to be synthesized into a national level “multi-hazard early warning system.”

Our expert respondents classified the benefits from these four national adaptation projects into infrastructural, institutional, and community categories.

### *3.1 Infrastructural Resilience*

Each of the four projects enhances physical and infrastructural resilience in some way. The project in Bangladesh sponsors 6,000 hectares of community based mangrove plantations, 500 hectares of non-mangrove mount plantations, about 220 hectares of dykes, and more than 1,000 kilometers of embankments. Bangladesh’s coastal forest today is almost a monoculture of mangroves. These monoculture forests have a limited ability to mitigate the impacts of climate

change as they have been viciously prone to pests, deforestation, and logging. Respondents mentioned how Bangladesh historically had a 500 meter buffer of natural mangroves to reduce the shocks of incoming storms and monsoons that has now been reduced to 12 to 50 meters in most locations. Stem borer attacks have felled thousands of hectares and created a lack of preferred mangrove species for regeneration, while illegal deforestation and logging have made matters worse. The Bangladesh project also develops early warning information and disaster preparedness systems in vulnerable areas to protect at least twenty villages and towns.

In Bhutan, planners are improving early warning systems and draining glacial lakes. Previously, the Bhutanese Department of Energy managed only a single station in Thanza, which housed two people with a wireless radio set and a single satellite phone that monitored glacial lake water levels. The problem is that the two people did not always report for work, have fallen asleep, and could have been killed by the GLOF itself. Under the project, the government will replace the manual system with an automatic one composed of gauges monitoring glacial lake bathymetry (depth) as well as sensors along rivers connected to automated sirens. The project will also eventually expand the automated warning system to cover more glacial lakes.

In Cambodia, infrastructural resilience will be improved by the construction and rehabilitation of retention ponds, canals, dykes, and reservoirs that due to years of neglect are currently in disrepair. Instead of repairing these irrigation systems using design parameters derived from historical hydrological patterns, the project aims to integrate climate forecasts into design parameters so that the infrastructure can withstand future climatic events such as droughts or floods.

In the Maldives, planners are deploying “soft” adaptation infrastructure. As one interview respondent explained:

The key to the [the project] is moving beyond hard infrastructure to soft protection, using ecosystems and trees as measures to improve resilience that are cheaper, environmentally more sound, and longer lasting than their capital- and technology-intensive counterparts. The sea wall around Malé, for example, cost \$54 million to erect, or \$12.4 million per kilometer. The Maldives has 2,002 kilometers of coastline, which would make protecting them all with a seawall a monumental \$24.8 billion enterprise. With the country's current annual GDP, it would take more than three decades to raise the funds for such a task, let alone build the sea wall. We've also got only \$9 million in total to work with for the [project]. What are we going to do, build half a kilometer of sea wall with the money?

This comment implies that one of the more innovative ways the project strengthens resilience is by deploying smaller-scale, less capital intensive "soft" measures such as planting mangroves or improving coastal vegetation, instead of building more of the "hard" and expensive seawalls shown in Figure 2.



Figure 2: A Multi-Million Dollar Tetrapod Seawall Breaks Waves in Male, the Maldives

Source: Authors.

### 3.2 Institutional Resilience

Adaptation efforts in our four cases focus not only on infrastructure but also improving institutions and propagating standards of good governance. In Bangladesh, the government provides free training sessions for local level administrators in disaster management and also facilitates input from civil society and community members in the formulation of state and national policies and regulations. As one respondent put it, “the institutional capacity including human resource quality in most Bangladeshi organizations, public and private, are weak and poor and need substantial improvement if the challenges of climate change are to be faced squarely.”

In Bhutan, training to government planners at national and local levels is intended to build institutional capacity, and to integrate input from stakeholders outside of government such as civil society and the private sector into national policies and regulations. Interview participants commented that the project will build capacity by “educating the major political

stakeholders of the risks faced by the country in case of a GLOF, especially policymakers.” One respondent noted that there has already been an increase in awareness in institutions with the high level steering committee and streamlining between agencies. As this respondent noted, “the aim has been to get interest for the project and related activities, for instance, building capacity for geologists and employment for civil engineering work.” The other main institutional work is of the community based disaster management committees. Their job is to highlight hazards and form district disaster management teams at village levels.

In Cambodia, enhancing the capacity of relevant government offices will be one of the project’s key components. The project will devise community development plans based on long-term climate forecasts and scenarios, budgeting for water resources investments that are appropriate given anticipated risks. Another objective is to augment capacity at provincial and community levels. As government bodies at these levels absorb newly-devolved administrative and fiscal responsibilities, there is an opportunity to change the execution of adaptation efforts. Instead of responding to disasters after the fact, capacity-building efforts intend to reform the planning processes and incorporate long-run climate forecasts and model output into ongoing decisions. Thus far, provinces have only been able to address immediate needs and lacked the resources to consider longer-term requirements. One consultant working on rural development issues said that “climate change is a very new concept. Most people do not know about climate change, even the NGOs. Some donors have allocated funds for climate change projects, but don’t know who can implement them and the NGOs don’t know how to get those funds.” Once the project’s capacity-building efforts prove successful in the piloted provinces, then lessons can be transferred to other provinces where adaptation aid funding is expected to be directed.

In the Maldives, institutional capacity is being strengthened through a new climate information system to collect, analyze, and disseminate data on the risks of climate change, as well as the costs and benefits of adaptation efforts. The project is also training government officials in risk analysis, hazard mitigation, and land use planning. By 2014 the goal is to train at least twelve senior decision makers and planners from national ministries in Malé as well as all senior decision makers in four provinces and atolls. As one respondent put it:

Institutional resilience is strengthened at several levels. Nationally, the [project] ensures that government work on climate policy is coordinated. That the harbor department talks with the land use planning department, or the disaster management people converse with the electricity supply people. This ensures that information is consolidated, and also that planners see climate policy from many different angles. At the provincial and atoll level, [the project] works with planners to enable them to better identify and respond to climate risks and vulnerabilities.

Part of this component involves participating with local island leaders to share knowledge and learn about local efforts at deploying soft adaptation measures. Participants noted that this sharing of knowledge “can create meaningful debate about which experiences have worked and which have not.” Another subcomponent strengthens knowledge management by connecting Maldivian policymakers into a global Adaptation Learning Mechanism, a platform of global experts on climate policy. This part aims to ensure that the good practices and lessons learned from the Maldives are exported to other countries, and also that knowledge from other countries in the network is transmitted into the country. The idea is to create a “critical mass” of experience with adaptation for least developed countries and small island developing states.

### *3.3 Community Resilience*

336           Lastly, each adaptation project enhances community and social resilience. In  
337 Bangladesh, revenues are disbursed to vulnerable coastal communities so that they can diversify  
338 income sources and occupational training. One especially innovative dimension of this  
339 component is its focus on the “Triple F” model of “Forest, Fish, and Food.” The coastal  
340 communities most vulnerable to rising sea levels—the places where mangroves need to be  
341 planted and forests replenished—are also those where farming and forestry are the primary  
342 sources of income. The “FFF” model attempts to maintain community livelihood and adapt to  
343 climate change at the same time by integrating aquaculture and food production within reforested  
344 and afforested plantations.

345           In Bhutan, a community awareness subcomponent is being implemented in three pilot  
346 districts: Punakha, Wangdi and Bumthang. District disaster management committees have been  
347 formed and training has been given for an integrated disaster management plan which will enable  
348 communities to identify hazards and vulnerabilities. Community leaders will then ostensibly  
349 prioritize their own ranking of hazards along with recommended solutions. Officials are also  
350 creating a zoning map to mark several safe evacuation areas and extremely unsafe zones. The  
351 final stage of the project will set up emergency operation centers at district administration offices  
352 to enable them to better handle crises. Communities are being trained in their response to  
353 calamities and emergency situations using mobile phones and radio broadcasts in addition to  
354 traditional sounding gongs and bells from monasteries. Figure 3, for example, shows posters  
355 depicting first aid and emergency response techniques in the case of a GLOF. One participant  
356 suggested that these efforts will improve community resilience by “giving communities a better  
357 understanding of the risks and hazards surrounding GLOF occurrences.” Another noted that “a  
358 better understanding of disaster risk reduction and community plans in case of disasters is

essential to community wellbeing. The GLOF project is helping sensitize not only community leaders and adults but the elderly and school children about hazards such as floods, landslides and earthquakes.” This information enables communities to better plan for where to locate infrastructure, homes, and farmland.

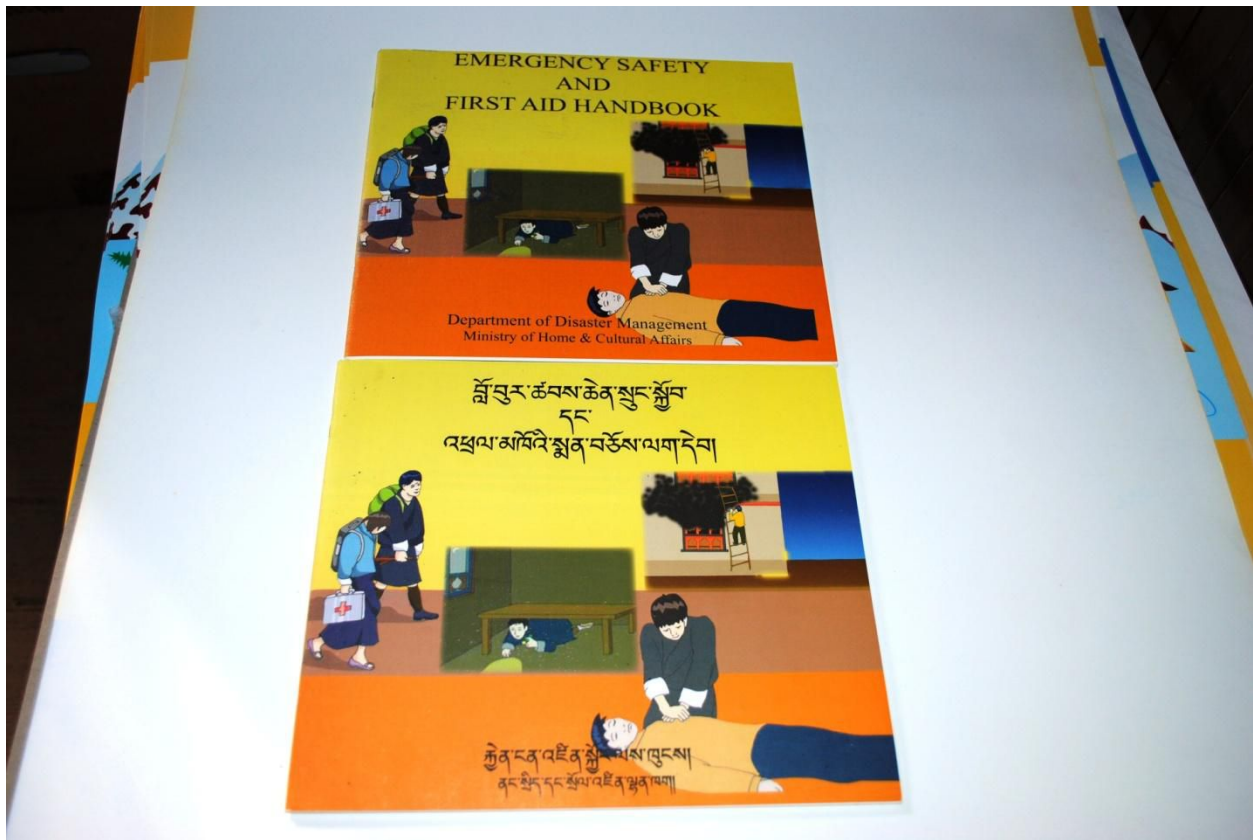


Figure 3: A Bhutanese Department of Disaster Management Poster on First Aid

Source: Authors.

In Cambodia, in addition to devolving ministerial functions related to adaptation efforts to local levels where possible, the decentralization reforms also shift more responsibility onto community groups. As one interviewee stated, “Funding for commune projects takes place at the provincial level. One hundred projects may be proposed, but there is only enough money for ten. They prioritize based on their available resources and those that lose get rolled over into the next year. Communes raise a lot of needs and proposals, but government is unable to meet those



needs and participation levels.” A consequent requirement is to improve financial management systems which would expedite the transfer of funds from international donors to communes and reduce the lead time for completing adaptation projects.

In the Maldives, planners are attempting to increase awareness of climate change in the outer atolls. One participant noted that the project will “help decentralized adaptation investment planning so that each island decides what to spend its own budget on, therefore creating incentive for islands to ‘pick best value for the money’ so that they have resources left to improve community welfare in other ways.” The program will also send “training teams” to remote islands to “create awareness among the community so that they can take stock of existing vulnerabilities and soft adaptation measures.”

#### 4. Discussion: Broadening the Notion of Resilience

Though context specific, these distinct infrastructural, institutional, and community benefits arising from Asian adaptation efforts suggest a revaluation of how resilience is currently conceived in climate policy discussions. The concept of resilience has emerged to be a central feature in discussions about how developing countries ought to manage climate-related risks, yet much of the current literature takes a somewhat narrow view.

For instance, Adger (1999: 252) writes that vulnerability to climate change is social and refers to the “exposure of groups or individuals to stress as a result of the impacts of climate change and related climate extremes.” He argues that vulnerability can be disaggregated into individual vulnerability, lack of access to resources, and declining social status of individuals within a community. Vulnerability requires three factors or dimensions: (1) exposure to a climate risk, or the extent to which physical or human or ecological assets are at risk; (2)

sensitivity, the internal characteristics of those assets that determine how they are affected; and  
(3) impact, as shown by the adverse or beneficial effects that result (Margulis et al. 2008).

Other studies discuss how resilience refers to the capacity of ecosystems, infrastructure, or technology to experience disturbance and still maintain function and control. Young (2010) notes that resilience can include the notion of robustness, the ability to cope with stresses without adapting, or the capacity to deal with stresses through adjustments that stop negative change. Ecosystem resilience generally entails handling stresses in an adaptive manner, in essence adapting to exogenous pressures, whereas engineering resilience frequently utilizes the concept of an internal equilibrium to determine how far a system can be displaced from its initial state and still return to it once disturbance has passed (Holling 1996).

Still other studies on resilience conceive of it as the ability of communities or countries to survive and recover from the impacts of climate change (Marshall 2010; Venema and Cisse 2004; Margulis et al. 2008). The Rockefeller Foundation (2010) writes that resilience includes understanding impacts, taking actions that prevent them, managing impacts while they are occurring, and recovering from them after they have occurred. Table 3 presents a small sample of other recent definitions of resilience from a small sample of the climate change adaptation literature.

**Table 3: Definitions of Climate Resilience**

Definition	Source
Capacity of an individual, community, or institution to dynamically and effectively respond to shifting climate impact circumstances while continuing to function at an acceptable level	Rockefeller Foundation 2010
The amount of disturbance a system can absorb and still remain within its same state; degree to which it is capable of self organization; and degree to which it can build its capacity for learning and adaptation	Jerneck and Olsson 2008 (quoting a definition from the Resilience Alliance)
The degree to which an institution or system can cope with change without collapsing, or, the ability of a system to absorb perturbations by actively adapting to an ever-changing environment	Harkes and Novaczek 2002
The amount of disturbance a system can absorb and still remain within the same state or	Klein et al. 2003

domain of attraction, and the degree to which the system is capable of self organization		
System's capacity to absorb disturbance and reorganize in order to retain the same function, structure, identity, and feedbacks, that is, remain robust		Magis 2010
Capacity for a complex system to absorb shocks while maintaining function		McDaniels et al. 2008
Capacity of a system to absorb disturbance and reorganize while undergoing change so as to still retain essentially the same function, structure, identity, and feedbacks ... without slowing degrading or even unexpectedly flipping into less desirable states		Folke et al. 2005

These definitions do imply that specific vulnerabilities may require different types of interventions. One strategy could emphasize risk reduction such as implementing stronger building codes for homes or designing evacuation plans. Another could focus on recovery such as having insurance in case a disaster strikes. Yet another could focus on vulnerability reduction, such as reducing the pollution of coral reefs so that they are not as stressed and can better handle climate change.

Our findings from the least developed Asian country case studies, however, suggest that these types of interventions interact at a systemic level; it is likely that communities need all types in order to improve resilience. Our case studies suggest that resilience has infrastructural, institutional, and community dimensions presented in Table 4.

**Table 4: Dimensions Of Resilience and Adaptive Capacity for Asian Countries**

Type of Resilience	Explanation	Dimensions
Infrastructural	Refers to the assets, infrastructure, technologies, or "hardware" in place to ensure the delivery of services that could be disrupted by climate change (such as electricity or water)	Resilient infrastructures tend to encompass relevance, flexibility, and diversification.
Institutional	Refers to the endurance of an institution or set of institutions, usually government ministries or departments, in charge of planning and community and infrastructural assets	Resilient institutions are strong; they can cope with new stresses and changes and maintain their core function and purpose. They tend to have permanence, rapidity, and legitimacy
Community	Refers to the cohesion of communities and the livelihoods of the people that compose them	Resilient communities tend to possess ownership, wealth, education, and access to knowledge and education that enable them to make decisions and respond to climate related challenges

Such a finding—that resilience is interstitial and multidimensional—has been confirmed by a few recent studies. McGray et al. (2009) investigated 135 case studies of adaptation efforts in developing countries, and noted three types of adaptive efforts were most useful:

- Building responsive capacity, such as improving communication between institutions, or enhancing the mapping or weather monitoring capability of a government institution;
- Managing climate risks, such as disaster planning, researching drought resistant crops, or climate proofing infrastructure;
- Confronting climate change, such as relocating communities or repositioning infrastructure in response to flooding or glacial melting.

Similarly, the World Resources Institute (WRI), in collaboration with United Nations Development Programme, United Nations Environment Programme, and World Bank (2008), argues that three dimensions to resilience exist. Ecological resilience refers to the disturbance an ecosystem can absorb without changing into a different structure or state. Disturbances can be natural, like a storm, or human induced, such as deforestation. Social resilience refers to the ability of a society to face internal or external crises and still cohere as a community and possesses a sense of identity and common purpose. Economic resilience refers to the ability for an economy to recover from shocks, and often entails having a diversified economy composed of members with a variety of different skills.

The problem is that the degradation or destruction along one dimension of resilience can affect the others; the influence can be both positive and negative. Depleting a forest, for instance, could reduce ecological resilience that in turn creates fewer jobs (affecting economic resilience) and erodes the community's social resilience (by causing a high proportion of migration or dissention within the community). Conversely, improved ecological resilience can

improve rents and revenue from logging (economic resilience) and also improve business skills and connection with markets (social). Klein et al. (2003) add that resilience can be reactive, making the present system resistant to change, or proactive, creating one that is capable of adapting to change.

## 5. Conclusion

Notwithstanding the diversity of adaptation efforts in Bangladesh, Bhutan, Cambodia, and the Maldives, our descriptive account of four ongoing adaptation projects in least developed Asian countries does reveal two preliminary conclusions. First is that adaption interventions straddle multiple spheres; they involve not only putting up hardware and infrastructure, the so called “climate proofing” or “climate hardening” strategies often backed by western donors (McGray 2009), but also efforts that attempt to address coordination issues, overcoming limited execution capacity, human capital constraints, and lack of knowledge. All four of our case studies couple adaptive improvements in technology and infrastructure with those in governance and community welfare. As Table 5 summarizes, Bangladesh is not only sponsoring dykes and mangrove plantations, it is incentivizing agriculture and aquaculture to improve community income and training local officials. Bhutan is not only altering the physical shape of glacial lakes and rivers, building shelters, and creating an early warning system, but educating public and private leaders about emergency preparedness and climate risks. Cambodia is not only experimenting with crops and rehabilitating canals and ponds, but educating provincial officials and empowering local villagers to decide on infrastructure investments. Maldivian planners are not only thickening coastal vegetation and nourishing coral reefs, but decentralizing planning and disbursing funds directly to local communities so that they can decide what is best for them.

**Table 5: Adaption Efforts in Least Developed Asian Countries and their Contributions to Resilience**

Country	Infrastructural Resilience	Institutional Resilience	Social Resilience
Bangladesh	Mangrove plantations, mount plantations, dykes, and embankments; early warning system	Training courses for local government officials in forestry	Coupling of forestry programs to income generation through forest products, fish, and food
Bhutan	Lowering glacial lake levels; deepening river channels; early warning system; climate shelters	Workshops for government officials at the nodal level	Community training in search and rescue, evacuations, and first aid
Cambodia	Climate-proofing of canals and communal ponds; experimentation with crop variation and diversity	Education sessions for provincial and local officials	Local empowerment over prioritization of climate proofing schemes
Maldives	Sea walls; replenishment of sea ridges; mangrove afforestation; beach nourishment; coral reef propagation; repositioning of water tanks	Decentralization of adaptation planning and management to local political units	Community control over adaptation investments

Ongoing projects are training civil services, creating new organizations responsible for aid coordination, handling different foreign groups and project ideas, and (in some cases) increasing the democratization of climate change related information, financial disbursements, or control over adaptation projects. Their efforts demonstrate the interconnected nature of adaptation efforts, and how they must expand beyond technology alone if resilience and adaptive capacity are to be strengthened. The key challenge for future adaptation efforts will be promoting different types of resilience—infrastructural, institutional, community—that do not tradeoff with each other, where improving one type is not to the detriment of the others. It is always up to organizations and planners to organize budgets across different categories, and ideal or optimal allocation will always be particular to local needs and circumstances. The implication is that truly resilient societies must possess all three forms of resilience. This underscores the holistic or systemic aspect of resilience.

Consider the case of a successful early warning system for extreme events or disasters which can be a consequence or impact of climate change. To build such a system, one would

need infrastructure (mobile phones, radios, satellites), institutions (organizations in charge of collecting data, operating the system, and disseminating information), and community members (who would receive and process information and then decide whether to act on it or not).

Similarly, effective storm resistant housing would be infrastructural (including building materials and roofs), institutional (proper incentives such as building codes and tax credits), and community based (in this case involving home owners or tenants).

Second, our study demonstrates the salience of a functions-based approach to resilience and adaptive capacity rather than an asset-based one. Community or social assets—things like higher wages or better technology—are useless if communities do not have the skills or capacity to use them. Knowledge and assets must be coupled with capacity and improved governance. This creates a more fluid and messy picture of adaptation efforts on the ground, but also one that is more realistic. Assets remain only potential until they are leveraged; and unless adaptation programs find ways to improve living standards, many may respond to national climate change priorities only by harming individual communities. Our study ultimately implies that analysts shift the focus slightly to look at functions, or what communities can actually do with their resources to adapt. This requires conceptualizing resilience not only as infrastructure and technology, but also the broader social and economic forces that need to occur so that communities can use their assets to manage climate risks.

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References

Adger, W.N. 1999. Social Vulnerability to Climate Change and Extremes in Coastal Vietnam. *World Development* 27(2), pp. 249-269.

Adger, W.N. 2003. Social capital, collective action and adaptation to climate change, *Economic Geography* 79 (4), 387-404.

Adger, W.N., Arnell, N. W. and Tompkins, E. 2005. Successful adaptation to climate change across scales. *Global Environmental Change* 15(2), 77-86.

Archer, D and S Rahmstorf. 2010. *The Climate Crisis: An Introductory Guide to Climate Change* (Cambridge: Cambridge University Press).

Ayers, J., Forsyth, T. 2009, 'Community-based adaptation to climate change: strengthening resilience through development', *Environment* 51(4), 22–31

Asian Development Bank. 2009. *The Economics of Climate Change in Southeast Asia: A Regional Review* (Manila: ADB, April).

Barbut, M. 2009. *Transfer of Environmentally Sound Technologies: The GEF Experience* (Washington, DC: Global Environment Facility).

- 555 Brown, M.A. and Sovacool, B.K. 2011. Climate Change and Energy Security: An Overview of  
556 Global Technology and Policy Options (Cambridge: MIT Press).  
557
- 558 Bunce et al. 2010. Policy misfits, climate change and cross-scale vulnerability in coastal Africa:  
559 how development projects undermine resilience. *Environmental Science & Policy* 13(6), 485-  
560 497.  
561
- 562 D'Agostino, A., Sovacool B.K. 2011. Sewing Climate-Resilient Seeds: Implementing Climate  
563 Change Adaptation Best Practices in Rural Cambodia, Mitigation and Adaptation of Strategies  
564 for Global Change (in press).  
565
- 566 Dexter, Lewis Antony. 1970. *Elite and Specialized Interviewing* (Evanston, IL: Northwestern  
567 University Press).  
568
- 569 Dimento, J.F.C., Doughman P. 2007. Climate Change: How the World is Responding, In Joseph  
570 F.C. Dimento and Pamela Doughman (Eds.) *Climate Change: What it Means for Us, Our*  
571 *Children, and Our Grandchildren* (Cambridge: MIT Press), pp. 101-138.  
572
- 573 Doria et al. 2009. Using expert elicitation to define successful adaptation to climate change,  
574 *Environmental Science & Policy* 12, 810-819.  
575

- 576 Drumwright, M.E., Murphy P.E. 2004. How Advertising Practitioners View Ethics, *Journal of*  
577 *Advertising* 33(2) (Summer), pp. 7-24.  
578
- 579 Economics of Climate Adaptation Working Group. 2009. *Shaping Climate-Resilient*  
580 *Development: A Framework for Decision-Making* (Washington, DC: Global Environment  
581 Facility, European Commission, McKinsey & Company, The Rockefeller Foundation, Standard  
582 Chartered Bank, and Swiss Re).  
583
- 584 Few, R. 2007. Climate change and coastal management decisions: Insights from Christchurch  
585 Bay, UK, *Coastal Management*, 35(2) 255-270  
586
- 587 Folke, C., Hanh T., Olsson P., Norberg J. 2005. Adaptive Governance of Social-Ecological  
588 Systems, *Annual Review of Environment and Resources* 30, pp. 441-473.  
589
- 590 Gibbs, M.T. 2009. Resilience: What Is It and What Does it Mean for Marine Policymakers?  
591 *Marine Policy* 33, pp. 322-331.  
592
- 593 Harkes, I., Novaczek I. 2002. Presence, Performance, and Institutional Resilience of the Sasi, a  
594 Traditional Management Institution in Central Maluku, Indonesia, *Ocean & Coastal*  
595 *Management* 45, pp. 237-260.  
596
- 597 Holling, C.S. 1996. Engineering resilience versus ecological resilience. In P. Schulze, editor.  
598 *Engineering within ecological constraints*. National Academy, Washington, D.C., USA, 31-44.

599

600 Jerneck, A., Olsson, L. 2008. Adaptation and the Poor: Development, Resilience, and Transition,  
601 Climate Policy 8, pp. 170-182.

602

603 Klein, R.J.T, Nicholls R.J., Thomalla F. 2003. Resilience to Natural Hazards: How Useful is  
604 This Concept? Environmental Hazards 5, pp. 35-45.

605

606 Magis, K. 2010. Community Resilience: An Indicator of Social Sustainability. Society & Natural  
607 Resources 23, pp. 401-416.

608

609 Mahoney, J. 2000. Path Dependence in Historical Sociology. Theory and Society 29, pp. 507-48.

610

611 Margulis, S., et al. 2008. The Economics of Adaptation to Climate Change: Methodology Report  
612 (Washington, DC: World Bank Group, December).

613

614 Marshall, N.A. 2010. Understanding Social Resilience to Climate Variability in Primary  
615 Enterprises and Industries. Global Environmental Change 20, pp. 36-43.

616

617 McDaniels, T., Chang S., Cole D., Mikawoz J., Longstaff J. 2008. Fostering Resilience to  
618 Extreme Events within Infrastructure Systems: Characterizing Decision Contexts for Mitigation  
619 and Adaptation. Global Environmental Change 18, pp. 310-318.

620

McGray, H. 2009. The National Adaptive Capacity Framework: Key Institutional Functions for a Changing Climate (Washington, DC: World Resources Institute, November).

McGray, H., Hammill A., Bradley R., Schipper E.L., Parry J.E. 2009. Weathering the Storm: Options for Framing Adaptation and Development (Washington, DC: World Resources Institute).

Meenawat, H., Sovacool, B.K. 2011. Improving Adaptive Capacity and Resilience in Bhutan, Mitigation and Adaptation Strategies for Global Change 16(5) (June), pp. 515-533.

Osborne et al. 2010. Evaluating Successful Livelihood Adaptation to Climate Variability and Change in Southern Africa, Ecology and Society 15, 27-40.

Ostrom, E. 2010. Polycentric systems for coping with collective action and global environmental change. Global Environmental Change, 20(4), 550–557

Peake, S., Smith J. 2009. Climate Change: From Science to Sustainability (Oxford: Oxford University Press).

Prouty, A.E. 2009. The Clean Development Mechanisms and its Implications for Climate Justice, Columbia Journal of Environmental Law 34(2), pp. 513-540.

- 643 Rawlani, A and BK Sovacool. 2011. Building Responsiveness to Climate Change through  
644 Community Based Adaptation in Bangladesh, Mitigation and Adaptation of Strategies for Global  
645 Change (in press).  
646
- 647 Rockefeller Foundation. 2010. Building Climate Change Resilience (New York: Rockefeller  
648 Foundation White Paper).  
649
- 650 Sovacool, B.K. 2009. Sound Climate, Energy, and Transport Policy for a Carbon Constrained  
651 World, *Policy & Society* 27(4) (March), pp. 273-283.  
652
- 653 Sovacool, B.K. 2011. Hard and Soft Paths for Climate Change Adaptation. *Climate Policy* 11(4)  
654 (July), pp. 1177-1183.  
655
- 656 World Resources Institute (WRI) in collaboration with United Nations Development  
657 Programme, United Nations Environment Programme, and World Bank. 2008. *World Resources*  
658 *2008: Roots of Resilience-Growing the Wealth of the Poor*. Washington, DC: WRI.  
659
- 660 Venema, HD, Cisse M. 2004. *Seeing the Light: Adapting to Climate Change with Decentralized*  
661 *Renewable Energy in Developing Countries* (International Institute for Sustainable  
662 Development).  
663
- 664 Victor, D.G., Morgan M.G., Apt J., Steinbruner J., Ricke K. 2009. The Geoengineering Option:  
665 A Last Resort Against Global Warming? *Foreign Affairs* 83, pp. 64-76.

666

667 Wilbanks, T.J., Leiby, P., Perlack, R., Ensminger, J.T., Wright, S.B. 2007. Toward an integrated  
668 analysis of mitigation and adaptation: some preliminary findings, *Mitigation and Adaptation*  
669 *Strategies for Global Change* 12(5), 713–725

670

671 Young, O.R. 2010. Institutional Dynamics: Resilience, Vulnerability, and Adaptation in  
672 Environmental Resource Regimes. *Global Environmental Change* 20(3) (August), pp. 378-385.

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689 Appendix I: Summary of Research Interviews and Site Visits

Date	Institution	Location	Number of Interviews/visits
May 2010	Rockefeller Foundation	Bangkok, Thailand	2
	World Resources Institute	Washington, DC, United States	2
	United Nations Development Program Regional Center	Bangkok, Thailand	1
June 2010	United Nations Development Program Bhutan	Thimpu, Bhutan	3
	Bhutan National Environment Commission	Thimpu, Bhutan	1
	Disaster Management Division, Bhutan Ministry of Home and Cultural Affairs	Thimpu, Bhutan	2
	Bhutan Gross National Happiness Commission	Thimpu, Bhutan	1
	World Wildlife Fund Bhutan	Thimpu, Bhutan	1
	Bhutan Department of Geology and Mines	Thimpu, Bhutan	2
	Punakha Dzongkhag Administration (Bhutan)	Punakha, Bhutan	1
	Bumthang Dzongkhag Administration (Bhutan)	Chamkhar, Bhutan	1
	Bhutan Department of Energy	Thimpu, Bhutan	1
	Bhutan Department of Agriculture	Thimpu, Bhutan	1
	Punakha Dzong Community (Bhutan)	Punakha, Bhutan	1
	Punakha Valley Township (Bhutan)	Punakha, Bhutan	2
	Wangdue Valley Community (Bhutan)	Wangdue Phodrang, Bhutan	2
	Chamkhar Valley Community (Bhutan)	Bumthang, Bhutan	1
	Bangladesh Forestry Department	Dhaka, Bangladesh	3
	Bangladesh Forestry Department	Noakhali, Bangladesh	1
	Bangladesh Forestry Department	Cox's Bazaar, Bangladesh	1
	Bangladesh Forest Research Institute	Chittagong, Bangladesh	2
	Bangladesh Ministry of Environment and Forests	Dhaka, Bangladesh	1
	Bangladesh Center for Advanced Studies	Dhaka, Bangladesh	1
	United Nations Development Program Bangladesh	Dhaka, Bangladesh	1
	United Nations Development Program Bangladesh	Cox's Bazaar, Bangladesh	1
	Hatiya Island Community (Bangladesh)	Noakhali, Bangladesh	1
	Anwara Upazila Community (Bangladesh)	Raipur Union, Bangladesh	1
	Cox's Bazaar Community (Bangladesh)	Cox's Bazaar, Bangladesh	1
	Moheshkhali Village Community	Cox's Bazaar, Bangladesh	1



	(Bangladesh)		
July 2010	United Nations Development Program Maldives	Malé, Maldives	6
	Maldives Climate Change and Energy Department	Malé, Maldives	4
	Maldives Ministry of Housing, Transport, and Environment	Malé, Maldives	3
	Maldives Meteorological Service	Hulhulé, Maldives	4
	Hulhulé Island Community (Maldives)	Hulhulé, Maldives	3
	Malé Harbor Community (Maldives)	Malé, Maldives	3
	Gan Island Community (Maldives)	Gan, Maldives	2
	Villingili Island Community (Maldives)	Villingili, Maldives	2
	Maradhoo Island Community (Maldives)	Maradhoo, Maldives	3
	Hulhumalé Island Community (Maldives)	Hulhumalé, Maldives	3
August 2010	Preah Vihear Department of Agriculture (Cambodia)	Tbeng Meanchey, Preah Vihear Province, Cambodia	1
	United Nations Development Program Cambodia	Tbeng Meanchey, Preah Vihear Province, Cambodia	1
	Krao Bao Village (Cambodia)	Kulen Etbong Commune, Kulen District, Preah Vihear Province, Cambodia	4
	Preah Klaing Commune (Cambodia)	Tbeng Meanchey District, Preah Vihear Province, Cambodia	4
	Sethakich Village (Cambodia)	Chhean Mok Commune, Tbeng Meanchey District, Preah Vihear Province	4
	Thanal Bek Village (Cambodia)	Thmey Commune, Tbeng Meanchey District, Preah Vihear Province, Cambodia	3
	Development and Partnership in Action Cambodia	Kampong Thom, Cambodia	1
	Chambak Village (Cambodia)	Taing Krasang Commune, Santuk District, Kampong Thom Province, Cambodia	6
	Cambodia Ministry of Environment	Phnom Penh, Cambodia	2
	Cambodia General Directorate of Agriculture	Phnom Penh, Cambodia	1
	United Nations Development Program Cambodia	Phnom Penh, Cambodia	2
	Cambodian Centre for Study and Development in Agriculture	Phnom Penh, Cambodia	1
October, 2010	Global Environment Facility	Delhi, India	1
	Global Environment Facility	Washington, DC, United States	2
	Pact	Delhi, India	2
	Stockholm Environmental Institute	Delhi, India	1

Paper Title: Integral Leadership Education for Sustainable Development: Development of an Integrated Model and Analysis of the University of Tokyo's Asian Program for the Incubation of Environmental Leaders  
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### Abstract

To date, there have been no strongly established theoretical frameworks in the field of education for sustainable development. This study developed an integrated framework for environmental leadership education, called Integral Leadership Education for Sustainable Development (ILESD). The framework is an application of the All Quadrant and All Level (AQAL) approach proposed by Wilber (2000, 2002). To construct an integrated theory for environmental leadership education, the current paper suggests a framework comprising four quadrants that are indicated by "It, Its, I, and We." After considering students' viewpoints, it has been found that ILESD has two types of integrated models in each quadrant: the inside and the outside. Environmental leadership itself is inside the student, while the program for environmental leadership is outside the student. Those integrated models, which enable us to examine the integration level and interaction of a program for environmental leadership development and environmental leadership itself, can assist in the holistic evaluation of such educational programs. The current paper applied ILESD to analyze the Asian Program for the Incubation of Environmental Leaders (APIEL), established by the University of Tokyo. The result suggests that APIEL accomplishes a certain level of integration, but also presents the following three challenges: (1) the establishment of environmental studies, (2) further development of curricula focusing on the development of environmental leadership, and (3) the establishment of an evaluation methodology vis-à-vis educational effectiveness. It was found that all of the issues addressed can affect the quality of education that otherwise assists in developing environmental leaders.

**Keywords:** Education for sustainable development, Environmental leadership, Integral approach, Evaluation methodology for education programs

**Brief Title:** Education for Development of Integrated Leaders for Sustainability

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Paper Title: An Integral Approach to Sustainability Assessment of Pastoral  
Livelihood System in the Inner Mongolia, Dryland China  
Track Title: 5e Agriculture and Regional Development  
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### Abstract

Nomadic pastoralism is one of the livestock production systems based on extensive land use and herd mobility. The system has adapted to climate variability for centuries especially in dryland. Worldwide, pastoralism currently supports about 200 million households and nearly a billion heads of animals including camels, cattle, and smaller livestock that account for about 10% of the world's meat production (FAO, 2001); however, many regional development and environmental protection programs aiming at improving living standard of nomadic households and grassland ecosystem are transforming traditional pastoral livelihoods around the world. One of the main assumptions of those government policies is that the provision of social services is best provided in settled urban environment. China's recent nomadic settlement project is one of those aiming at grassland protection through promoting fencing, sedentarization, individual rangeland use rights, and preventing over-grazing.

To assess the effects of such regional development programs and environmental policies, an holistic and integrated framework is necessary. Recently, the concept of sustainability assessment emerged. It is an umbrella term that embraces a range of processes which aim at integrating the sustainability concepts into decision-making, and the processes that may carry the labels including sustainability appraisal, sustainability impact assessment, or integrated assessment (Pope, 2006). However, there are still discussions on what sustainability means and how it can be incorporated into assessment processes in ways that recognize the holistic nature of the concept and tackle the inter-related issues of integration and trade-offs of different aspects of sustainability (Pope, 2006).

In this context, we propose using the integral framework of All Quadrants, All Levels (AQAL) approach developed by Ken Wilber (2001) in sustainability assessment. The core of Wilber's integral approach is a 4-quadrant framework which describes multiple aspects of reality. According to Wilber (2001), all phenomena in the world can be classified into four quadrants. These quadrants are four distinct dimensions of reality, or ways of viewing the same occurrence from four different perspectives. They can be located in the interior and exterior of both individuals and collectives. Wilber's integral framework has been applied to a variety of fields, such as ecology (Hargens, 2005), education (Akiyama, *et al.*, 2010), international development (Hochachka, 2008). It also could be beneficial in the field of sustainability assessment.

In this article, we further developed Wilber's framework to analyze historical changes in pastoral livelihood system in the Inner Mongolia, dryland China. Using the modified integral framework, we especially examined how regional development and environmental policies have affected pastoral livelihood system in the area. We collected various statistics to understand the changes in pastoralists' socio-economic situation. In addition, interview data collected between 2003 and 2011 were analyzed to qualitatively explore the personal and cultural changes which can not be captured by macro-statistical data. We also carried out hydrological and meteorological observations between 2002 and 2011, while long-term observed groundwater level data were collected. We employed Landsat and SPOT satellite data to analyze the land use and land cover changes during the past 30 years.

The results demonstrated that regional development and environmental policies induced the weakening of pastoralism in the Inner Mongolia. In addition, the policies improved neither socio-economic situation of nomadic households nor grassland ecosystem. After the collapse of the people's

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communes in 1981, policies were taken to facilitate the sedentarization of Mongolian nomads. An important step was the land distribution to single household under the scheme of the Household Responsibility System. With each household gaining use right of pastureland, fences were introduced to reduce the conflicts regarding property rights among nomadic households. The sedentarization process has intensified significantly after the implementation of the Western Development Strategy since 2000. In terms of changes in exterior-collective (social systemic) quadrant, the sedentarization resulted in the sudden changes in the lifestyle of nomadic pastoralists. The lack of the experiences of urban life and stall-feeding of livestock has resulted in the marginalization problem of nomads in local society. After the implementation of settlement project, the former nomads who fail to find jobs in urban sector depend on government subsidies for their lives. The sudden changes in their lifestyle also led to the loss of hope (interior-individual quadrant which refers to personal or intentional aspect) as well as loss of indigenous culture closely related to the nomadic herding on grassland (interior-collective quadrant which refers to cultural aspect). In addition, the rapid speed of lifestyle changes among the nomadic society also has a presumably negative impact on the environment (exterior-individual quadrant which refers to physical aspects). After the distribution of grassland, the lack of mobility of herding resulted in the intensive use of pastureland, which consequently undermined the nomads' ability to adapt to the climate changes.

To conclude, the 4-quadrant framework adopted in this study illustrated that the development of the exterior-collective quadrant in the form of regional development programs and environmental policies resulted in the breakdown of a balance between rangeland ecosystem and nomadic pastoral system. This study also showed that the 4-quadrant framework can enhance not only theory but also practice in the fields of sustainability assessment.

## References

- Akiyama, T., Li, J., Tokunaga, T., Onuki, M., An, K. J., Hoshiko, T., Ikeda, I. 2010. Integral Approach to Environmental Leadership Education: An Exploration in the Heihe River Basin, Northwestern China, the University of Tokyo. *Proceedings of the 8th International Symposium on Southeast Asian Water Environment*, 40-49.
- Food and Agriculture Organization of the United Nations (FAO). 2001. *Pastoralism in the new millennium*. Animal Production and Health Paper No. 150, UN Food and Agriculture Organization, Rome, Italy.
- Hochachka, G., 2008. Case studies in integral approaches in international development. *Journal of Integral Theory and Practice*, 3(2), 58–108.
- Pope, J. 2006. Editorial: What's so special about Sustainability Assessment? *Journal of Environmental Assessment Policy and Management* 8(3), v-x.
- Wilber K. (2001). *A Theory of Everything: An Integral Vision for Business, Politics, Science and Spirituality*. Shambhala Publications Inc., Boston, Massachusetts.

Paper Title: Ecological modernization and pesticides in Oman  
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### **Abstract**

During the last two decades Oman has experienced rapid economic development and this has been accompanied by environmental problems. Manufacturing and agricultural output have increased substantially, but initially this was not balanced with sufficient environmental management. Although agriculture in Oman is not usually considered a major component of the economy, government policy has been directed towards diversification of national income and as a result there has been an increasing emphasis on revenue from agriculture and an enhancement of production via the use of irrigation, machinery and inputs such as pesticides. In recent years this has been tempered with a range of interventions to encourage a more sustainable production. Certain pesticides have been prohibited; there has been a promotion of organic agriculture and an emphasis on education and awareness programs for farmers. The last point is of especial relevance given the nature of the farm labour market in Oman and a reliance on expatriate and often untrained labour. Given the centralised nature of the government in Oman, it provides a unique set of insights into the processes of putting sustainable agriculture into practice and the factors that may work against this.

This paper explores the changes in the agricultural sector in Oman through the lens of Ecological Modernisation (EM) theory. EM primarily aims to explain and understand the main mechanisms and dynamics in environmental reforms of production and consumption practices. Given their significant impact on production as well as the environment and human health, the primary focus of the research was the use of pesticides. The paper draws out the process by which agricultural policy is developed by the upper levels of the government executive within such a centralised system, including support for international agreements and protocols, and the mechanisms by which these policies are implemented and how impact is perceived at the farm level especially in relation to pesticide use and pesticides safety. A group of respondents was assembled comprising senior government officials, leaders of environmental non-governmental organisations and others. Using semi-structured interview techniques this group helped identify the key aspects of and problems with government support for agriculture. They provided insights on the various trade-offs at play within policy, including barriers to the expansion of agriculture in Oman and the effectiveness of the current model of knowledge transfer adopted by the Ministry of Agriculture and Fisheries towards the largely small scale farming community.

The research also explored the state of knowledge at farm-level regarding the safe use of pesticides and what factors could enhance or indeed operate against the spread and implementation of that knowledge. In particular, the research addressed the potential for farmer-to-farmer (horizontal) spread of knowledge as a means for addressing what is often perceived to be a relatively ineffective 'official' extension service. The effectiveness of the existing extension services in relation to pesticide safety was explored through a detailed survey of current pesticide use, labour awareness of pesticide regulation and transfer of knowledge between farmers. Respondents from within and outside existing farmer associations were surveyed in order to analyse the dynamics of knowledge diffusion and as affected by obstacles such as competition between farmers, cost sharing, involvement of labours, time management and practical, hands-on follow-up sessions. From these results the potential for development of farmer-lead knowledge diffusion models was explored.

Keywords: Oman, pesticides, ecological modernisation

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Paper Title: 'Modernizing the marshes':  
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---

### An Ansoms and Jude Murison

This chapter looks at the local impact of the nation-wide government's policy to modernize agricultural production in the marshes. Rwandan swampland since long has been an important natural resource for local peasant communities. All together it covers about 10 % of Rwandan territory. The Rwandan government has worked out a swampland 'valorisation' policy, inspired by the objectives to maximize agricultural output while using land more efficiently and more productively. The organisational approach adopted for the swamplands is essentially different from that applied in the hills where authorities aim to register all land through individual property titles. Article 29 of the land law mentions that, "swampland belongs to the state. It shall not definitively be allocated to individuals and no person can use the reason that he or she has spent a long time with it to justify the definitive takeover of the land" (GoR, 2005). As no definite rights on swamp plots can be allocated to individuals, the government assumes the role of principal swampland developer.

This approach may take two forms. In some locations, the government makes swampland available, in concession, to private investors. In others, the national government mandates local authorities to allocate marshland plots to farmer cooperatives that use collective cultivation systems. Furthermore, national policy makers impose a uniform technical solution (monocropping) upon all local setting. They consider this method to be more productive than the traditional system which combines several food crops. They further foresee in specific regulations that enforce the cultivation of very particular crop types (market-oriented 'high-value' crops such as rice, sugar cane, maize, etc.). In a sense, the current cultivation practices used in the marshlands are a pilot experience with agrarian commercialisation policies that Rwandan authorities want to implement in the hills. And in fact, they are a pilot experience for **ambitions of national and international development actors with the African agrarian space more widely: introducing commercially-oriented production techniques in an efficiently organised production system.**

In a first part, this paper analyses the Rwandan agricultural policy – and marshland policy more in particular - from a **historical perspective**, illustrating how the Rwandan state has always tried to exercise control over local production systems. We also embed the current policy rhetoric in a **broader context**, by situating it in the debate on the necessity of a Green Revolution for Sub-Saharan Africa (as proclaimed in the World Development Report 2008). We illustrate how the rhetoric around the concept of the Green Revolution allows policy makers to 'sell' far-going measures in favor of agricultural modernization as food-securing and poverty-reducing initiatives.

In a second part, the paper analyses in-depth case study material to frame **how this modernization policy impacts upon farming systems at the local level**. The paper draws upon qualitative field research carried out in 2007 and 2011 in 6 different rural settings located next to a marshland in the

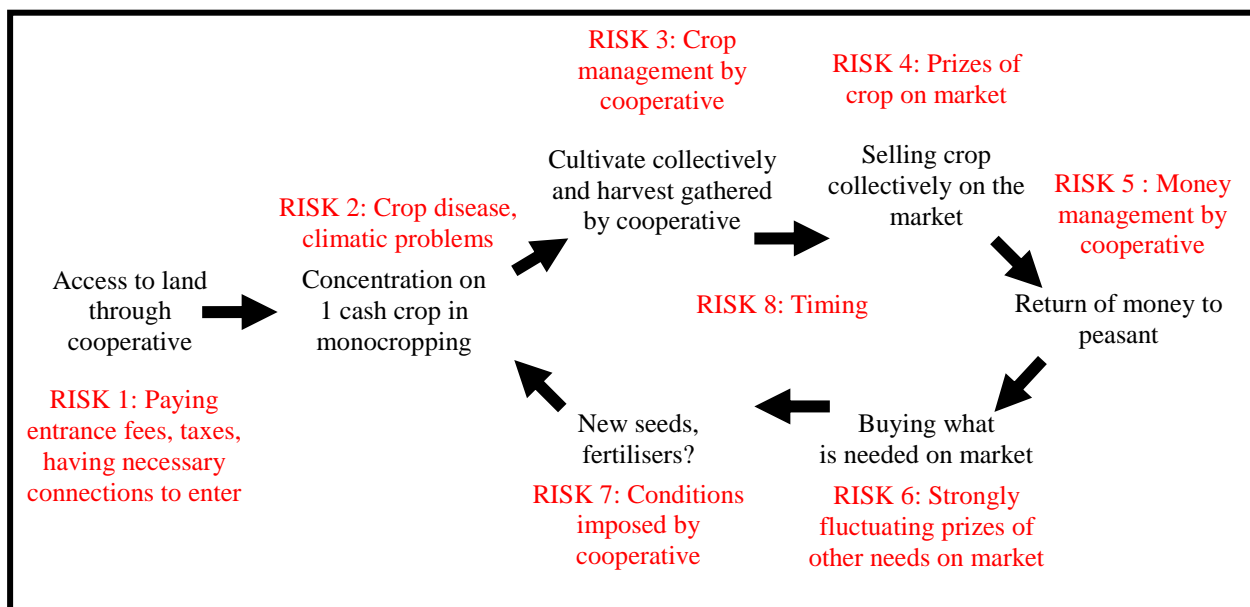
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Southern Province of Rwanda. In each setting, the authors conducted over 15 focus group interviews (in both years) with diverse socio-economic farmer groups to study their local livelihoods and the impact of rural policies. Our research has looked in particular at the ways in which diverse types of farmers are affected by the swampland modernization policy.

Based upon our case study material, we frame how the technical and organizational reorganization of the swamplands introduces **additional bottlenecks into local farming systems** that contrast with the logic of risk-minimizing behavior of small-scale farmers. These bottlenecks are:

- 1) Securing access to land through a membership in the cooperative (this means having to find the necessary means to pay the entrance fees and taxes, and having the necessary connections to secure access);
- 2) Obligation to concentrate one's production on one cash crop in a monocropping system (which implies a high risk in case of crop disease or climatic problems);
- 3) Obligation to cultivate collectively with the harvest gathered by the cooperative (so what in case of famine; and is crop storage by the cooperative efficiently done?);
- 4) Provision that the cooperative sells the crop collectively on the market (risk of prize fluctuations on that market, is the cooperative an efficient negotiator);
- 5) Assumption that the money flows back from the cooperative to the peasant (many cases of corruption, non-transparent management of resources);
- 6) The farmer is dependent upon the market for a large part of his needs and is supposed to buy this with the income generated through his sold commercially-oriented production (how to deal with strongly fluctuating food prices on local markets);
- 7) The farmer has to insert him/herself into the cooperative's logic in terms of provision of seeds and fertilizers (what conditions are imposed);
- 8) This whole cycle takes a lot of time (whereas farmers are often confronted with immediate needs).



As an alternative, the chapter proposes to allow for diversified marshland cultivation systems where purely subsistence and commercially-oriented logics are allowed to coexist and not pushed into a one-size-fits-all logic. It proposes for policies to leave individual farmer households the free choice to choose from a *stairway of options*, with at the bottom step: allowing pure subsistence farming, at the second step: providing subsidized technical inputs like seeds and fertilizer, at the third step: improving farmers' physical access to markets, at the fourth step: stimulating locally-owned (!) collective strategies to increase bargaining power on markets, and at the fifth step: stimulate value adding activities such as storage and processing.

In its conclusion, the paper calls into question the fundamental foundations of Rwanda's current agricultural policy. It frames how the current 'maximal-growth' strategy results in a highly skewed developmental path with limited trickle-down potential. As an alternative, the paper pleads in favour of exploring the potential of a broad-based inclusive growth model that would build upon the knowledge

and enhancement of the capacities of rural small-scale farmers. Striving for a more inclusive form of growth seems to be crucial, not only for poverty reduction, but also for long-term stability and peace in Rwanda.

Paper Title: Sustainability values: is there a clear understanding and support?  
Track Title: 1b  
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To be submitted to track 1b: Whose sustainability? Environmental and social justice  
Preferred form of presentation: oral

**Abstract:**

Contemporary societies are increasingly aware of negative social and environmental impacts of human activities and struggle to implement measures to mitigate them. The concepts of sustainability and sustainable development attempt to redefine our understanding of how societies should work. A sustainable world would be not only economically viable but would also remedy current social and environmental challenges.

Developments towards a sustainable world are visible and there is much action taken to address issues of human rights, social inequalities and environmental degradation. Debates over defining sustainability and its sub-elements, over measurements and achievements are quite intense in developed nations. In spite of that, little is known about the involvement of countries outside the Western world towards the goal of sustainability. Their role is not, however, a trivial one, since major difficulties are encountered in those countries preventing a sustainable world to become a reality.

More specifically, in recent decades there are many countries openly embracing liberalisation and democratisation of their institutions towards a fair society and a free-market economy. Countries in Eastern Europe eagerly adopted social, economic and political measures to rapidly change their institutional systems. The communist ideology prevailing prior to 1989 did no longer receive support. In spite of its negative impacts on local economy and population, this ideology emphasised a number of values that, ironically, are now at the core of the sustainability agenda. Equality, secure employment and community cohesion are perhaps among the most known such values underpinning communist ideology. Institutional transformations in these countries were accompanied by a denial of any principles linked to communism. There is also a widespread aversion towards such values that are believed to have altered the quality of business life. The new governmental agenda centred upon economic achievements, putting aside values not directly linked to economic growth. Such developments seem to be at odds with the growing emphasis on sustainability in the Western world. However, many of Eastern European countries are currently European Union members or in the process of becoming members. European Union is among the most significant actors in the world in the field of sustainability. Thus, there are pressures also on Eastern Europe to follow a sustainable path of development.

Given the apparently conflicting relationships between the prevailing economic values promoted in Eastern Europe and sustainability principles, we are interested to explore the role sustainability plays in this region. In more particular, we seek to understand what the concept of sustainability actually means, i.e. what are the core values underpinning sustainability as it is conceptualised in Eastern Europe. Furthermore, we aim to explore the significance of such values as equality, security employment, community cohesion and human rights for this geographical region and their relationship with the sustainability concept. Such an analysis would shed light on the tension between economic and social values in Eastern Europe. It has the potential to identify impediments in developing a sustainable agenda in this region and could possibly have public policy relevance.

This study is empirically-driven and draws its data set from Romania, a country joining recently the European Community. The study scrutinises printed media materials and focuses on discussion of sustainability and sustainable development. The choice of mass media as a research material is



motivated by the role media play in contemporary society. Mass media reflect important debates taking place in society but have also the ability to shape public opinion. The data is gathered from a wide range of Romanian printed media. Collected materials are analysed with a textual interpretative approach. More, specifically, the approach consists in a close reading of texts, followed by codification and interpretative processes.

The study is currently in the stage of data collection, thus no preliminary results can be offered at the moment.

Paper Title: Development as a Trojan horse?  
Foreign Large Scale Food Production and Land Use in Ethiopia  
(Abstract)  
Track Title: 5f Land Acquisitions  
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The 2007/2008 global food crisis triggered many countries that are dependent on food imports to find alternative ways of ensuring their food security. Among them, countries from South East Asia, Europe and the Middle East are the main actors in large-scale agricultural investment in Sub-Saharan Africa. Ethiopia, a country known for recurrent droughts and resulting food insecurity, appears to attract major investment interest, the sizes of land allotted to foreign investors varying between 3,000 hectares and 122,000 hectares (Dessalegn 2011).

These unprecedented large scale land acquisitions meet with contradictory views among Ethiopians. On the one side, there is the argument in favor of these transactions - mainly advocated by the Ethiopian government and other proponents - that these investments create a better social infrastructure (such as schools, roads and hospitals), generate employment, provide access to markets and technology for farmers and bring in higher regional or national tax revenues. On the other side are scholars, who argue that this development intervention may have negative consequences for the ecosystem and the livelihood of the people at large.

Since many researchers indicate that there is a lack of empirical evidence to prove or disprove the above arguments (Deininger 2011, Zoomers 2010), the present research project explores how these large scale land acquisitions by foreign companies are shaped by global and local policy makers and development agents, and how they affect the local community livelihood and the environment. An innovative analytical and theoretical model, called 'Zones of Intermediality', is used to analyze the multi-stakeholder interactions that go with these large-scale foreign land transactions. Characteristically, the model includes both qualitative (ethnographic fieldwork) and quantitative research (semantic connectivity analysis and the use of Geographic Information Systems). Thus, it is able to map place (geographic location) and space (ontological and social spaces) according to the definitions and interpretations of the various stakeholders in large-scale land acquisitions. Applying the model in a case-study of Bako Tibbe, located in the South West Shewa Zone of Oromia region, the paper aims at gaining profound insight into the different levels of impact of the large-scale land acquisitions by three investors (one local and two Indian investors) since 2009.

## References

- Deininger, K. (2011) "Challenges posed by the new waves of farmland investment", *The Journal of Peasant Studies* 38 (2): 217-247.  
Dessalegn, R. (2011) Land to Investors: large scale land transfers in Ethiopia. *Forum for Social Studies, policy debates serious* No.1.  
Zoomers, A. (2010) "Globalisation and foreignisation of space: seven processes driving the current global land grab", *The Journal of Peasant Studies* 37(2):429-447.

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<sup>1</sup> This research is part of the Integrated Programme "Development as a Trojan Horse? Foreign Large-scale Land Acquisitions in Ethiopia, Madagascar and Uganda" funded by The Netherlands Organization for Scientific Research directed by Dr Sandra J.T.M. Evers (VU University Amsterdam).

Paper Title: Markets and eco-innovation : bonds pricing.  
Track Title: 4b  
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Title of paper: Markets and eco-innovation : bonds pricing

Indicate preferred format for the presentation: Oral

Climate change is an inevitable reality, and coupled with the global recession and economic downturn, amplifies its threats. So far global economic downturn and debt crisis had harmful impacts on carbon markets, and threaten to reroute the needed resources from climate programs and practical action. Needless to say that economic crisis response has become a priority. At the same time, it is important to remember that in the light of current global events climate change and related effects may lead to even more severe global crisis if not addressed. Innovation is a powerful mechanism to alleviate devastating effects of climate change and capacity to innovate should be mobilized as much as possible via various mechanisms.

Earlier research emphasized that ecological issues have to be addressed on a global scale, and proper legislative mechanisms shall be developed. Such a mechanism will require integrated quantitative metrics to monitor the progress and trends of national development. One of the ideas presented in [1] was introduction of an eco-innovation potential at the national level as an additional measure of country's capacity to improve its eco-balance [2].

At the moment there is a lot of interest in incorporating environmental and social factors into market pricing mechanisms. This research is considering a model for bond pricing incorporating eco-innovation potential which may be an alternative for innovation markets and an additional incentive for eco-innovation policies implementation.

## References

[1] Bakhtina, V.A. (2011), Innovation and its potential in the context of the ecological component of sustainable development, Sustainability Accounting, Management and Policy Journal 2 (2), pp. 248-262

[2] Global Footprint Network (2011), available at: [www.footprintnetwork.org/en/index.php/GFN/page/basics\\_introduction](http://www.footprintnetwork.org/en/index.php/GFN/page/basics_introduction)

Paper Title: Delivering national policy at the local level: The role for local authorities in the implementation of the UK's flagship Green Deal policy

Track Title: 3b

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Preferred form of presentation: **Oral**

## ABSTRACT

The Green Deal (Department of Energy and Climate Change, 2011) is one of the flagship policies of the UK Government's Energy Act (Energy Act c.16, 2011, HM Government, 2011). This Act makes provisions for a step-change in the installation of energy-efficient measures in homes and businesses, which is intended to play a large part in helping the UK Government to meet its legally binding target of an 80% reduction in greenhouse gases (compared with a 1990 baseline) by 2050 and achieve a transition to a low-carbon economy. In this paper we wish to examine the local implementation of this national policy, considering the role for local authorities and other local-level actors in its delivery, as well as the challenges and opportunities that are likely to emerge.

The Green Deal will be a market-led scheme that provides a financing mechanism for householders and businesses to install a number of energy-efficient measures and make the repayments on their energy bills, without the need for upfront capital investment. By its nature, the Green Deal will involve delivery at a local level. Local authorities will, therefore, have a significant role to play in the implementation of the Green Deal, but at this stage it is up to each individual authority to decide how it will do this. There are, however, three broad approaches that an LA may adopt: as a provider (directly coordinating finance and delivery), as a partner working with other providers to facilitate delivery, or as a promoter to advocate the scheme to residents.

From a series of semi-structured interviews with stakeholders in both the public and private sector across the city of Leeds we will draw insight into the barriers and opportunities that the Green Deal presents for each. We will assess the roles that a local authority could take to enhance uptake of the Green Deal within its administrative area and capture the favourable outcomes that this could offer, such as job creation, economic growth, regeneration of deprived areas, the alleviation of fuel poverty, private-sector investment and increased health and wellbeing for citizens.

This work builds on previous work conducted by this group (Bale *et al.*, 2011a) in which we considered the role for a strategic energy body that would operate under a local authority and provide a strategic vision for the area, facilitating investment and partnerships. We will, therefore, also consider the benefits a strategic energy body could provide in helping to facilitate local authority involvement in the Green Deal and co-ordinate the range of actors involved in delivering the scheme locally.

We have also conducted related work in developing and applying complex dynamical network models to analyse the implications of behaviour of householders and interactions through the social networks connecting the householders on energy technology uptake (Bale *et al.*, 2011b). We have examined the influence that a local authority could have on increasing uptake of a given technology by promoting the sharing of energy information through existing networks. We plan to apply this approach to simulate the implementation of the Green Deal, drawing on consumer data from various sources. Whilst we do not intend to present the modelling work in detail in this paper, we will draw on insights from this work to illustrate examples of how and where local authorities can influence uptake of the Green Deal.

The UK claims international leadership in the arena of energy and climate change policy. This work will contribute to the analysis of whether a flagship UK policy is likely to be able to deliver its objectives. It will draw on the interviews and the Leeds City Council case study on the UK Green Deal, and lessons from other similar programmes, such as the Property Assessed Clean Energy (PACE) financing

programme legislation (which operates in 16 states across in the United States) (2011). This will inform understanding of issues relating to the local implementation of national legislative policy that aims to contribute to a low-carbon transition.

2011. PACE Assessment 5 Protection Act of 2011. *H. R. 2599*. 112<sup>th</sup> Congress 1<sup>st</sup> Session ed.

BALE, C. S. E., FOXON, T. J., HANNON, M. & GALE, W. F. 2011a. Making the case for strategic energy planning within local authorities: a study of the city of Leeds. Submitted to *Energy Policy*.

BALE, C. S. E., MCCULLEN, N. J., FOXON, T. J., RUCKLIDGE, A. M. & GALE, W. F. 2011b. Local authority interventions in the domestic sector and the role of social networks: a case study from the city of Leeds. *Energy & People: Futures, complexity and challenges* Oxford.

DEPARTMENT OF ENERGY AND CLIMATE CHANGE 2011. The Green Deal: A summary of the Government's proposals. London.

ENERGY ACT C.16 2011. London: HMSO.

HM GOVERNMENT 2011. The Carbon Plan: Delivering our low carbon future. London: The Stationery Office.

Paper Title: Implementing the ecosystem approach: distilling insights from experience to date  
Track Title: 5g Nature Conservation  
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### Abstract:

The Ecosystem Approach (EA) as defined by Convention for Biological Diversity (CBD), is 12 complementary and interlinked principles that promise “a strategy for the integrated management of land, water and living resources that promotes conservation and sustainable use in an equitable way” (<http://www.cbd.int/ecosystem/principles.shtml>). As such the EA promises to be a key approach to achieving sustainable development. However, although the EA claims it is potentially in many situations and habitats, its principles can seem relatively aspirational and ‘high level’.

How should the CBD’s 12 principles be applied in practice? Is there are particular scale at which it should be applied? Is the EA really useful given the plethora of existing policies and recommendations for those making decisions about our natural resources? Ten years have elapsed since the CBD principles were agreed, so this is a good opportunity to review what has been learnt.

In this presentation we review and synthesise international experiences to discuss, what is and isn’t an EA and what applying the EA can look like in practice. We will present the development of a framework used to assess and learn from existing practice.

The initial findings of our review support that there is no ‘one size fits all solution’ to translate the EA into practice but it always essential that the 12 principles are seen as interlinked rather than a menu of options to be chosen from. We suggest that the EA can promote equitable management that is resilient to future environmental and societal changes, but it is particularly relevant where multiple stakeholder groups have an interest in a site or area to be managed.

Our framework and initial experiences in reviewing examples of the EA, are relevant to informing existing and future management efforts to promote sustainable development across the world. Therefore, the paper is of interest to academics, policy makers and practitioners alike.

Paper Title: Cross analysis of theory (Systemic Design) and practice  
(case studies) to design and test framework for Local Economic  
Development  
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## ORAL PRESENTATION

### Introduction: problems to face

Local Economic Development (LED) is of considerable significance within the cultural context in which it operates and is currently becoming an increasingly important part in international cooperation. The possibility to enable scenarios of bottom-up economic and social development, led by local actors, is gaining ground in the last decade. In this context of steady change, the national and local governments, like businesses and other organizations must rethink development strategies in order to lead the change to widespread prosperity of the people and the ecosystem. To centre these goals the implementation of an approach that goes beyond a specific and punctual solutions is needed, so it tends to create connections between local material, energetic and informational resources, generating multiple and complex solutions. In particular, energy is a *common good*, considered as need fundamental and shared by the society, but also it is an *individual right* to increase our own capability. The socio-economical growth is strictly connected with the access to a secure and affordable supply of energy, because with a permanent availability of energy in its various forms, especially electricity, people can learn, produce, share and increase their activities in wide meaning. But the emissions associated with energy generation and consumption is also central to number of key environmental issues. Therefore, the aim is to define sustainable models using a holistic theory that take into account not only the economical and environmental aspects, but also the social ones. In Systemic Design (SD) theory, the economic, social and environmental benefits are required through the flows and the efficiency in the use of resources.

### Methodology: combination of desk and field research

The research methodology used to reach that goal is based on the combination of theory and practice that resolves in a cross analysis. The theory of SD and the practice of Case studies are tackled with the same keys: *what, why, when, where and how*.

What is SD is clarified by a historical excursus of its origins (Generative Science, Cluster Theory, Industrial Ecology, and Industrial Symbiosis); to understand the differences and the evolution in the time, and by its theoretical principles, to underline their innovation and enhancement. Why the SD methodology was used to design LED centred on green energy production is embedded in its historical background (and its innovation), and in its consistency. The evolution of the concept that industrial processes can work like nature shows how the SD theory adds some crucial elements to previous theories making them more effective. When and Where the Systemic thinking begin to be defined: in biology, physics, psychology and ecology but only in 50s it started to influence also the engineering and economics, generating the systemic management. How the SD is used in this research: in the theory for planning and in the practice for reflecting. This research is built upon showing the European energy situation, synthesising the information from relevant literature about SD, and analysing eight case studies. The need for a better understanding regarding SD concepts contributes to intensify local sustainability and to test it.



The motivations in choosing these eight case studies stay in the approach, the size, and the experiences. The selection of case studies is based on the production of green energy, the complexity they have with more or less large networks of companies, the compliance with the SD principles, above all the tendency to zero emissions. The different size of plants allows understand the regional effects with macro systems and the local effects with micro systems. In that way, the limits in using local resources to produce green energy become evident. The localization of the cases is divided in two specific country of Europe: Sweden and Italy. The first country was chosen for its long experience in bioenergy and because its approach to that field is more holistic than other experienced countries. The second country is chosen because of its strong theory in SD and because of supporter feeling to help that country to reach the European targets in the production of energy from renewable resources.

A cross analysis of the cases and of the theoretical and practical parts is crucial to find the main results for designing the framework. That analysis wants to turn the theoretical knowledge into pathways of change suitable to the needs and capacities specific to regions or localities.

### **Conclusions: implications of results for future policy**

Rather than setting out with a proven “one-fits-all” solution in hand to catalyse the development of Systemic Design networks, this research primarily focuses on continuously fine-tuning and approach so as to make it best suited to dynamic region specific contexts.

The main result of this research is a framework supporting the evolution of a new economy with different sets of industrial relations, where long-term sustainability and success of interdependent activities are priorities over maximising economic growth or competitive advantage of individual entities. In light of the improved understanding, the results become evident and the framework designed, together with a experimentation, that was improved into practice in the Italian micro-system (*Agroindustria snc*).

The green energy produced in small plants and distributed in the territory favours the success and the sustainability. Reading in the right way the environment is possible to design the right technology that produce green energy and that is connected with other renewable resources. Such agile system can be a new paradigm for both energy efficiency and reliability for any region or country. When the linkages between materials, energy, people and their knowledge are mapped out clearly, efficient pathways towards sustainable ways to use and re-use untapped resources will become apparent. Using these networks, we can innovate collectively to create energy systems that are beneficial for the people the environment, and pleasurable for all. Green energy produced in small plants and distributed in the territory helps the success and the sustainability.

### **References**

- Bistagnino, L. (2011). *Systemic Design. Designing the productive and environmental sustainability*. Bra (CN), Italy: Slow Food Editore.
- Capra, F. (2002). *The hidden connections: A science for sustainable living*. New York, NY: Doubleday.
- Germak, C. (2008). *Man at the centre of the project. Design for a New Humanism*. Turin, Italy: Allemandi & C.
- Lovins, A. B., & Hawken, P., & Lovins, L. H. (1999). *Natural capitalism: Creating the next industrial revolution*. New York, NY: Little Brown&Company.
- Mandelbrot, B. B. (1982). *The Fractal Geometry of the Nature*. New York, NY: W.H. Freeman and Company.
- Maturana, H. R., & Varela, F.J. (1972). *De Maquinas y Seres Vivos. Una teoria sobre la organizacion biologica*. Santiago de Chile, Chile: Editorial Universitaria.
- McCormick, K. (2007). *Advancing Bioenergy in Europe. Exploring bioenergy systems and socio-political issues* (Published doctoral dissertation). The International Institute for Industrial Environmental Economics, Lund, Sweden.
- Meadows, D. (1999). *Leverage points: places to intervene in a System*. Hartland, WI: Sustainability Institute.
-

Mirata, M. (2005). Industrial Symbiosis. A tool for more sustainable regions? (Published doctoral dissertation). The International Institute for Industrial Environmental Economics, Lund, Sweden.

Nicolis, G., & Prigogine, I. (1989). Exploring complexity. An Introduction. New York, NY: W.H. Freeman & Company.

Pauli, G. (2010). The Blue Economy: 100 Innovations inspired by nature that can generate over a decade 100 million jobs. Taos, NM: Paradigm Publications.

Peccei, A. (1974). Quale futuro? L'ora della verità si avvicina. Milan, Italy: Biblioteca dell'EST.

Rifkin, J. (2009). The Empathic Civilization: the race to global consciousness in a World in crisis. New York, NY: Tarcher.

Sgreccia, E. (2007). Manuale di Bioetica. Fondamenti ed etica biomedical, 1. Milan, Italy: Vita e Pensiero.

Shrödinger, E. (1946). What is Life? The physical aspects of living cells. Cambridge, UK: Cambridge University Press - The Macmillan Company.

Von Bertalanffy, L. (1969). General System Theory: Foundations, development, applications. New York, NY: George Braziller, Inc.

Paper Title: A Checklist for Sustainable Product Development: the example of innovative lightweight technologies in automotive product engineering

Track Title: 4a

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**Abstract: 18th Annual International Sustainable Development Research Conference, Hull, UK, June 2012**

Josef-Peter Schögg

The early product development phase is of great importance not only for the reduction of costs but also for the improvement of a products' sustainability performance, since the possibility of improvements combined with the extent of possible savings decrease steadily during the engineering process. This particularly applies for innovative lightweight technologies in the automotive industry, since they require the application of new materials and the development of new practices.

Usually there are insufficient data and experiences of these innovative technologies concerning their sustainability aspects available. This lack of information and the high rate of uncertainty hinder the application of traditional sustainability assessment tools, such as Life Cycle Assessment, which moreover almost solely considers environmental aspects and bring designers and engineers, who have significant influence on the sustainability performance of the technologies they are developing, into the focus.

Existing tools, which provide guidance for the planning and design process, such as the "Ten golden rules" by Luttrup and Lagerstedt (2005), "Ford of Europe's Product Sustainability Index" by Schmidt and Taylor (2006), the EcoDesign Checklist by Brezet and van Hemel (1997) or the "UNEP Design for Sustainability impact profile" UNEP (2009) were tested regarding their applicability for this particular purpose but were found only partially suitable in their original form.

The reasons were the lack of a full sustainability perspective, too general formulations or the need of too detailed information, which is hardly available in the intended development phase. The choice of the scientific and strategic foundation for the newly developed tool, the Sustainability Checklist for innovative lightweight technologies (SC) was therefore made in favor of the Framework for Strategic Sustainable Development (FSSD), not only because Ny (2006) and Hallstedt (2008) both developed

methods for sustainable product development based on the FSSD and its backcasting methodology but also because of

- the broad acceptance of the FSSD in the scientific community,
- the particular focus on all dimensions of sustainability most other concepts are missing,
- the tested applicability to induce life cycle thinking of designers and engineers,
- and not at least because of the fact, that the FSSD provides a foundation for a comprehensive implementation of sustainability measures in a company, why the SC thus can be extended to corporate activities (like production) or be integrated into a consistent sustainable product development process covering the whole product life cycle.

Against this background the overarching research question: “How can a sustainability perspective be integrated into early phases of automotive development by applying the FSSD approach?” and the following main requirements of the SC were defined. It should

- allow the qualitative assessment and valuation of sustainability aspects in early phases of automotive development with a specific focus on innovative technologies,
- facilitate the integration of awareness for sustainability into day-to-day business,
- trigger life cycle thinking among executives, designers and engineers, and
- support decisions over different technologies based on the sustainability evaluation.

In order to meet these requirements, the SC was designed as a checklist comprising of polar questions which are categorized into the four life cycle stages engineering, production, usage and end-of-life phase. The questions aim at the consideration of sustainability aspects which derive from a top down analysis of key categories for sustainability in automotive development and are linked to one or more of the four sustainability principles of the FSSD.

Along with the evaluation if an aspect is considered or not, the polled executives have to state the relevance of the aspect for the evaluated technology and have to give a qualitative description of the measures undertaken for its consideration. If an aspect is considered relevant, but no measures were yet undertaken, necessary To-Dos have to be defined in order to overcome this sustainability gap. It is therefore the main aim of the evaluation to reach a state, in which all relevant sustainability aspects are taken into account. Therein is another link to the FSSD and its A-B-C-D methodology since it encourages a backcasting from sustainability principles.

Due to its qualitative design, the SC can be applied as decision support tool as early as in the first concept development phase, since it provides a holistic overview over the sustainability performance of the technology under consideration. However it is also applicable for more detailed assessments and the evaluation of necessary actions and solutions for overcoming violations with the four sustainability principles occurring during the whole product development process. A first exemplary test run has shown that executives were able to identify a variety of sustainability gaps, for which improvement options were defined, which to some extent have already been successfully implemented. Since the SC also provides a quick overview over the necessary actions and their degree of fulfillment, the evaluation and documentation of actions undertaken towards the compliance with the sustainability principles as well as Life Cycle Thinking among employees is encouraged and facilitated.

#### References:

- Brezet, H. & van Hemel, C., (eds.), 1997.** *EcoDesign: a promising approach to sustainable production and consumption*. Paris: UNEP.
- Hallstedt, S., 2008.** *A foundation for sustainable product development*. Dissertation. Blekinge Institute of Technology Sweden.
- Luttropp, C.; Lagerstedt, J. 2006.** *Ecodesign and the Ten Golden Rules: generic advice for merging environmental aspects into product development*. Journal of Cleaner Production. Vol. 14, No. 15-16, pp. 1396 – 1408.
- Ny, H., 2006.** *Strategic Life-Cycle Modeling for Sustainable Product Development*. Dissertation. Blekinge Institute Of Technology. Sweden.
- Schmidt, W.-P.; Taylor, A., 2006.** *Ford of Europe's Product Sustainability Index*. In: Proceedings of



---

13th CIRP International Conference on Life Cycle Engineering. Leuven May 31st – June 2nd,  
pp. 5 – 10, Leuven.

**United Nations Environment Programm, 2009.** *Design for Sustainability – A Step-by-Step Approach.* Available at: [www.d4s-sbs.org](http://www.d4s-sbs.org) (Accessed May 21th 2011)

Paper Title: Access systems to sustainable compost transport in Ghanaian Savanna  
smallholdings.  
Track Title: 5e Agriculture and Regional Development  
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Growing populations in peri-urban West Africa reduce land availability and associated soil fertility, representing a decline in natural capital. Smallholder farmers respond to this with different strategies, each requiring various types of capital, described in the livelihoods approach to development as physical, financial, human and social. Global and local institutions determine peoples' access to these capitals. This paper will illustrate these access systems at the local scale, showing that farmers' strategies are only sustainable if effective social institutions are in place to facilitate them. The example that will illustrate this linkage between environment, society and economy is composting, an organic technology designed to effect sustainable soil fertility management. In particular, the focus will be upon the systems through which people access the vehicles they use to transport compost to their fields.

Compost is environmentally and economically sustainable – cheaper than chemical fertiliser, it establishes soil organic matter, improving water retention, nutrient use efficiency and soil biological activity. However, smallholders' limited financial and physical capital means they struggle to carry enough compost to their farms, constraining the extent to which they can use it sustainably.

The study examines how these issues occur in two savanna villages in Northern Ghana. As successive generations of smallholders inherit diminishing land patches, they adopt composting to maintain their farms' productivity. In these communities, farmers hitherto used bicycles and headpans to transport compost. The study devised an experiment to examine the characteristics and viability of systems through which they gained access to these and four other vehicles: bullock, donkey and hand carts and wheelbarrows.

In 2010, sixty farmers agreed to participate in the experiment by testing at least two of these forms of transport under three different access systems. Firstly, 37 of the 60 continued to use the bicycles and 23 the headpans they already owned to carry their compost. Secondly, 52 joined participatory groups instigated within the study to gain access to wheelbarrows and a donkey and cart, appointing a facilitator to oversee those vehicles' maintenance. Thirdly, ten who owned bullocks used a hired cattle truck and nine a handcart. In addition, some participants autonomously hired bullock trucks and handcarts outside the experimental context, and other farmers approached the participatory groups in order to hire their donkeys. Adding to quantitative data recording how many people used each form of transport, all 60 farmers were interviewed thrice about their experiences. They ranked the different forms of transport they had used and justified their opinions. Another valuable tool was participant observation.

The results showed that smallholders used different types of capital to access vehicles through various systems at three scales - the individual, the household and the community. Three main themes became apparent: the role of financial capital and markets and that of social capital in participatory groups were two that the study had aimed to examine. A third that emerged from the data was the role of social capital in traditional obligation.

Financial capital was used at an individual scale as people used their own bicycles and headpans. When richer individuals purchased larger vehicles, that financial capital acted across the community scale to facilitate hire markets, mostly within but occasionally between villages.

Social capital was also implemented at the community scale in the participatory solution. Farmers negotiated with each other to arrange when they would use the group-owned donkey and wheelbarrow.

The social capital of senior farmers acted in a less formal way at the household scale to oblige junior household members to assist them in carrying compost. Social capital also functioned at multiple scales when both large and small vehicles were lent and borrowed between household, lineage and community members in the traditional socioeconomic system of reciprocity and sharing. This was an important mechanism for farmers who could not afford to own or even hire the largest, most efficient vehicles, but sometimes had the social capital that facilitated borrowing.

Individuals' private accumulation of financial and physical capital seemed an expedient route to sustainable compost carriage in this context. The participatory group was difficult to maintain and to some extent began to resemble an ownership situation under the facilitators' direction, although they did not accumulate profit. Also, when people bought their own vehicles this facilitated not only a hire market but also the traditional sharing and borrowing system that ensured many in the community had access to a vehicle at some point. However, participant observation revealed that the poorest smallholders did not appear in the self-selecting survey and had scarce time for formal data collection. These farmers rarely had the social capital necessary to borrow others' vehicles or even make compost. Interviewees also indicated that a participatory group was more likely to slightly improve the access of these poorest people to physical capital. This informed the conclusion that a range of different access mechanisms, acting at different scales, are necessary to make compost transport, and indeed sustainable agricultural practice in general, available to the widest range of farmers. Compounding this, the three scales and themes identified in the results overlap within farmers access systems - they hired vehicles between and within communities, shared *and* hired the group donkey s and lent to kin, household and community members according to traditional obligations.

These overlaps extend to further actors and scales. Here the themes of transport and soil fertility have interacted at a local level, but they sit within wider national and global agricultural development contexts. Actors and processes framing this case study are the Structural Adjustment Policy that removed fertiliser subsidies in the 1980s, the state that reinstituted them in 2008 and the NGOs and private lenders who offer pre-season interest-bearing fertiliser loans.

Policy-makers and non-state actors seeking to implement sustainable development must therefore consider which systems best facilitate smallholders' access to the capitals they need for agriculture. Links and synergies between such systems at multiple scales are valid sites for future research, constructing a holistic picture of how sustainable different practices can be in different contexts. Further useful work can then focus on how to facilitate them.

Paper Title: A New Sustainable World Order (of knowledge):  
Six Steps to the Implementation of Intrinsic Sustainable Development

Track Title: 1c  
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**Abstract**

It is the diverse, complex, interdependent and interactive knowledge regions of Sustainable Development that make it difficult to handle. It is no small wonder then that politicians and business leaders do not take direct and positive steps to change our societies and systems to increase sustainability since there is frequently no simple answer – that is, there is no simple answer if you are too embedded in knowledge of the human world as it has become in the last few centuries.

There is however a simple answer and it is now emerging amongst us as science reveals more about the origins and interrelations of things. It is not an answer that is being fashioned or designed for increased sustainability but that will be its effect. Nor is it an answer that many people will accept and yet they will change in accordance with its consequences. It is an answer that is so simple that it will not be widely appreciated but it has the potential to change much if not all that we know of the human sciences. It is also an answer with a history.

In this paper, we sketch out this answer using Foucault's approach to epistemic analyses (Foucault 1970) and scientific evidence for the new episteme that is emerging (Birkin and Polesie 2011). Evidence for a new episteme has been accumulating for many decades in many disciplines. This provides a radical approach to overcoming sustainable development problems that changes not so much *what* we know but *how* we know. This approach is generic and profoundly multidisciplinary with the potential to change many things from abstract economics to the meaning and values we use in everyday life. But the main arguments of this paper concern issues relating to the practical implementation of Intrinsic Sustainable Development, the form that sustainability acquires in the new episteme which has been named the "Primal" episteme (Birkin and Polesie 2011). Whilst this implementation has the potential to affect many disciplines, the focus of this paper is its effects on business. These steps are listed below.

**Step 1: Turn reality on its head**

Traditional formulations of accounting and neoclassical economics including free markets theorising are often taken to be the realities within which businesses operate. Indeed the 2011 climate change talks were affected by the "more urgent realities" of the financial crisis. But the re-ordering of knowledge in the Primal episteme changes this: the logical belief systems that support traditional formulations of accounting and neoclassical economics may now be argued to be fantasies whilst real knowledge is empirical and pragmatic.

**Step 2: Participate**

The new realities of the Primal episteme include an ontology of interconnected events or, more simply, relations. In this episteme, participating in relations becomes the key to knowing and managing businesses. This underwrites a different approach to business strategy: one that goes from using power and resources to force a narrow, if economically successful, way forward to one of being skilful in detecting changing circumstances in a balanced economic, social and environmental agenda and having the flexibility to adapt to reap the rewards.

On a personal level, participatory living in the Primal episteme requires a higher level of mindfulness. This approach results in an open-ended enquiry of experience.

**Step 3: Value *being* more over *having* more**

One consequence of new Primal realities is a revised view of ourselves in terms of the satisfactions, goals, meaning and motivations that constitute our lives. The Primal episteme is occupied by participants who find their satisfaction and fulfilment enriching their experiences with emotional and other psychological interactions. These changes are of course of paramount importance to those businesses that exist to satisfy human needs.

**Step 4: Work for Multiple Benefits**

The idea that businesses maximise only economic gains is a consequence of the Modern episteme and it is not valid within the Primal episteme. Primal businesses work to optimise a *Triple Top Line* of economic, social and environmental gains.

**Step 5: Follow Ecological Economics**

In recent decades there has been a development of disciplines that integrate environmental aspects with traditional forms of economics, accounting and management in such as environmental economics, accounting and management. These can be regarded as way markers in the broader transition to the reordering of knowledge in the emerging episteme. Within the Primal episteme, participation in relations means that business themselves are embedded in relations and these may

be identified and described better using an ecological approach. Hence ecological economics is the form that economics takes in the Primal episteme.

#### Step 6: Educate for the New Episteme

The ordering of knowledge in mainstream business and management education has little to do with the broader relations that are known to constitute business in the Primal episteme and this may be verified in the text books now used. The whole complex, interactive, life creating and life sustaining regions of Nature for example are typically absent or briefly mentioned as a source of resources. A new form of education for business is required in which the relations between business and the social and natural worlds are treated as equally important as economic relations.

Finally this paper considers the opportunities to consolidate sustainable development research within many disciplines that are regarded as independent within the Modern episteme. In particular the consequences of the new, pragmatic and empirical reality are considered with regard to the dominance of traditional economics now enjoys over other social sciences. Conclusions are provided.

#### References

Birkin, F.K. and Polesie, T. (2011). *Intrinsic Sustainable Development: epistemes, science, business and sustainability*. London: World Scientific Press.

Foucault, M. (1970). *The Order of Things*. London: Routledge.

Paper Title: Absence of nature: A remaining flaw in business theory

Track Title: 3d

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Paper suggested for the 18<sup>th</sup> Annual ISDRC, Track 3d: Redefining Development

#### Abstract

During 2012, the United Nations Conference on Sustainable Development ("Rio+20") marks the twentieth anniversary of the so called Earth Summit in Rio de Janeiro. That year, 1992, also produced a couple of anecdotes worth reflecting upon when we consider what has been achieved and what's left to do in order to approach and possibly even reach a sustainable development.

One of these stories was produced through an experience by Herman Daly (recounted in e.g. Daly 1995). Working at the World Bank at the time, Daly suggested the inclusion of the environment into a diagram depicting the economy, and that the diagram would show the later as a subsystem to the former. The suggestion was not only refuted but also explained, by the Bank's Chief Economist Lawrence Summers, to not match "the right way" to look at things (Daly 1995:667). Summers' magnificent and influential career, including MIT, Harvard, the US Treasury (under Bill Clinton), Barack Obama's National Economic Council, and tennis playing with Federal Reserve's Chair Alan Greenspan, indicates that he should know what he is talking about. At the time of writing, Summers is also named as Obama's preferred new president for The World Bank, to succeed Robert Zoellick.

Consistent with Daly's intentions when writing about his experience, this story indicates a way of perceiving the world that has been, and may still be, conventional among influential people active within the spheres of economics and business. Such a World-view has also been promoted by mainstream literature. Undeniably, if visions and models in which nature is non-existent or assumed as infinite or fully substitutable are still prevalent, we have a formidable impediment to sustainable development. Using a Schumpeterian term to frame basic understandings about the World, Daly concludes that the very idea of sustainable development makes no sense unless one has a "pre-analytic vision", in which the economy is a subsystem to a larger system whose carrying capacity it must respect (Daly 1995:667-668).

The second anecdote from 1992 relates directly to the Rio conference and may shed some light on the issue of why intelligent and educated people, just like Summers and other important scholars, analysts and decision-makers, deny apparently common-sense features of their external world and fairly unambiguous cause-effect relations. This anecdote is plainly the infamous statement attributed to President Bush (the 1<sup>st</sup>) during a press conference prior to the Earth Summit: "The American way of

life is not negotiable (UN 2010:7).

Ever since, the US administration has been criticized for obstructing progress, e.g., in global climate negotiations, and development paths are no more sustainable now than when positions were voiced in Rio twenty years ago. Rather, main indicators like atmospheric levels of carbon dioxide (annual averages at Mauna Loa up from 356 ppm to well over 390 ppm) and ecological footprints of humanity (now exceeding biocapacity with more than 50%, compared to a rough 20% at the time of the first Rio Summit) show that the situation has deteriorated (NOAA 2012; Global Footprint Network 2010).

Obviously, the Americans are not the only ones to be held responsible, and very many of us have reasons to ask ourselves if our lifestyles – our consumption patterns, privileges and priorities – are negotiable. The absence of substantial responses over these two decades may thus be explained by vested interests or by a lack of profound concern for the “others” over space and time which are embraced within sustainability discourse. In another critical text, Herman Daly (1993:439) has even suggested that chanting the mantra of sustainability is unrelated to action; rather, we do it to “absolve us from our addiction to robbing the future.”

This may draw our attention to another central feature of mainstream economic and business theory, fields which are very influential in guiding societal action. That is the tendency to, following Adam Smith, emphasize the individual and his preferences when activities are described or prescribed (cf. Armour 1997). Hence, faced with collective environmental problems, we appear to be guided by theory that, over the years, have denied any substantial and independent role for nature and built on the assumption that “decisions reached individually will, in fact, be the best decisions for an entire society” (Hardin 1968:1244).

Certainly, theory evolves, and the spheres of economics and business in academia cannot have remained unaffected by the growing bulk of scientific evidence and the accompanying awareness of major environmental problems that has been emerging in society at large. Fields like Corporate Social Responsibility and Ecological Economics appear to have gained in importance, and “green” issues have entered into more traditional areas such as strategy and marketing.

Focusing the heterogeneous field of business theory, this paper provides an attempt to indicate its state in terms of two dimensions deemed to be crucial in the quest for sustainable development. First, to what extent and how is nature recognized, two decades after the first Rio conference, and, second, how do definitions of values and agents conform to a situation where radical change is required in our development path, to meet the collective challenges posed by major environmental problems?

The method used is to assess a broad selection of mainstream textbooks, used at international Business schools. A number of keywords and definitions are chosen to represent the treatment of the two issues. Preliminary results regarding the role of nature show an amazing conservatism and absence of adaptation to a new situation for the business disciplines; a situation in which the capacity of the Earth no longer allow for accelerating exploitation of natural resources and expansion of human societies. Consequently, the paper is concluded with a discussion on the need to reform mainstream business theory

Paper Title:	Grassroots Sustainability Associations: Creating Space for Sustainable Consumption Practices
Track Title:	4d Consumption and Lifestyles
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It is now widely recognised by academics in the field of sustainable development, practitioners, and policy makers that community participation is vital for the transition to sustainable development. Fortunately, in recent years there has been a surge throughout the United Kingdom of people connecting with others in their community to form grassroots sustainability associations to collectively tackle issues of climate change and sustainability. These include not only geographic communities e.g. neighbourhoods but also of work, education or leisure. Many of the associations that are formed create projects that allow users to consume resources more sustainably, such as garden-share



schemes, energy libraries, food co-operatives, farmer's markets, and organic vegetable growing classes, to name just a few. They may also arrange and participate in protests and lobbying in order to change government policy. These groups add to the pluralistic approach to sustainable development by creating niche spaces in which they educate and enable others in the community to adopt sustainable lifestyle practices. I have termed these groups "grassroots sustainability associations".

Human resources, such as skills and knowledge, are the attributes that members bring to an organisation. A literature review in the paper has found that human resources, provided by members who volunteer their time, are vital to the work of grassroots sustainability associations. However, no literature was found on exactly which human resources are provided or how they translate into action. This paper makes use of findings from a pilot case study using qualitative interviews with members of a grassroots sustainability association called Green Action, based in the student union at the University of Leeds, UK. First, this paper outlines the human resources that are provided by members to grassroots sustainability associations, as evidenced in this case. Second, the case study demonstrates how this grassroots sustainability association creates spaces in which these human resources can be transmitted between members. Third, this paper shows how in this case a physical space such as an allotment or food co-op that was originally created as an alternative system of consumption can become a space for gaining knowledge about sustainability issues and for skills-sharing, which leads to the adoption of further sustainable lifestyle practices. It will demonstrate how the learning that takes place in these spaces, through the transmission of human resources, creates more human resources for the association. This adds therefore, to the capacity of the association to meet its aim of being a "working practical example of an/the alternative autonomous lifestyle which we are hoping to move towards" (Green Action 2011). This paper concludes that Green Action has successfully created not only systems for sustainable consumption but also alternative niche spaces for learning about sustainable consumption issues, within the mainstream academic system of the university.

Paper Title: Assessing the Sustainability of Wastewater Treatment Technologies in the Petrochemical Industry  
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### Abstract

Selecting the most suitable industrial wastewater treatment technology is not only about providing the best technology at the lowest cost, but also about sustainability, including social and environmental acceptance, and institutional feasibility. This paper demonstrates and evaluates a method that may be used for wastewater treatment technology assessment and selection in an industrial context, with a specific focus on biological wastewater treatment in a petrochemical company. The technology assessment objectives are formulated as complexity, generality, approach, lead time and resources, focus, as well as data used. These objectives are used as criteria for the development of a technology assessment method; a multi-criteria decision analysis technique to compare and rank the wastewater treatment technology alternatives against the identified technical, socio-economic and environmental objectives. Using a petrochemical operation in South Africa as a case study, the paper provides a systematic analysis of eight wastewater treatment alternatives; to test the proposed technology assessment method and thus determine its usefulness as a technology assessment technique. The investigation suggests that the method managed to achieve most of the technology assessment objectives of the organization. Suggestions for further development of the technology assessment technique are made accordingly.

Paper Title: Beyond Sustainability? Not beyond sustainability, but beyond the so far established sustainability conceptions  
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The sustainability topic celebrates its 20<sup>th</sup>, 25<sup>th</sup> or even 40<sup>th</sup> anniversary depending on whether one takes the beginning of its societal institutionalization processes with Rio 1992, the Brundtland report 1987, or the beginning of the societal debate after Stockholm 1972 and the Meadows report in 1972 as birthdays. However, the results arising from decades of societal discourse don't look promising. Global warming, overuse of resources, environmental degradation, population growth, and social inequality: the problems related with these global issues still seem to aggravate rather than being diminished. Moreover, even a superficial overview on the use of terms like "sustainable" and "sustainable development" within the societal discourse reveals that the term covers a wide variety of meanings and interpretations leaving the impression that sustainability has become a catchword to cover whatever one is tempted to put into. Greenwashing is thereby by far not the worst misuse. Against this backdrop, the question has been raised within the scientific community whether sustainability really serves what it pretends to do namely to function as a global role model to steer strategic decision making in regard of the three core challenges motivating the very idea of sustainable development: scarcity of resources, fragility of ecosystems, and social inequality. Hence, should we go beyond sustainability, because sustainability cannot serve a steering role model to tackle the most important global problems?

The goal of this paper is to argue that this question is seriously mistaken. There is no point to go beyond sustainability as the steering role model for societal strategic decision making. The point rather is to critically review the so far established scientific contributions in rationally framing the sustainability idea. If one assumes that science in a domain such as sustainability has the task to contribute to rationalizing societal deliberation and negotiation ("contributing to informed decision making"), and if one additionally takes into account the total incoherent state of sustainability conceptualizations within science, then one should not be very surprised on the current "anything-goes"-situation within the societal discourse. I am thereby not saying that clarity within science automatically leads to clarity within societal deliberation and negotiation. Of course not. However, if heterogeneity dominates science one cannot be surprised that heterogeneity dominates society. Accordingly, sustainability science should first have a critical reflexive look at its achievements before suggesting something new. The argument runs as follows:

I shortly analyze the basic constituents of the sustainability idea to establish adequacy conditions for (theory, i.e. science driven) sustainability conceptions (cf. Burger & Christen 2011, however the criteria will represent an improvement of what was developed therein). I also argue that these constituents steer institutionalization processes.

I categorize the multitude of scientific proposals (such as capital stocks, welfare approaches, minimal necessary condition approaches, resilience, natural step, environmental sustainability, adaptive management, reflexive modernity etc.) according to three main categories (i.e. (a) justice, (b) environmental protection, and (c) societal processes).

I demonstrate that the three main categories each represent one of the main elements within the sustainability idea, thereby, however, always neglecting others.

Against the backdrop of that result, I interpret the so far established sustainability conceptions as being reductionists (ethical or environmental or societal reductionism). Additionally, all of them basically reflect the disciplinary premises of the domain in which there are established.

As a result, I sketch the most important tasks to overcome the rather poor conceptual state sustainability science is in – not to vote for a single solution or to demonstrate how a specific conception such as a capability based one could look like. By identifying criteria what a sustainability conception has to cope with, I strive for paving the way towards progress within sustainability science such that we will be better able to rationally frame and contribute to societal deliberation and negotiation.

Burger, P., Christen, M. (2011): Towards a capability approach of sustainability. Journal of Cleaner Production, 19, pp. 787-795.

Paper Title: Large scale land conversion caused by oil palm and timber plantations in Sumatra: Driving indirect land use change by migrants and small scale farmers in Riau province  
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Food, energy and climate change mitigation are increasingly competing for the remaining land resources. The FAO estimates that land needed for food production must increase significantly by 2050, requiring an additional 70 million hectares. The need for land necessary to satisfy the growing demand for biomass, most notably biofuel production under the International Energy Agency (IEA) alternative policy scenario will require an additional 52.8 million ha by 2030. With current highly fluctuating oil prices, this results in more intense expansion of large scale biofuel crop plantations, often at the expense of food crop production areas of local communities. In Indonesia, such pressures on the availability of land for rural small scale producers are caused by the continuous expansion of large scale oil palm plantations. Although initially planted for use as a cooking oil and an ingredient in the processed food industry, its emerging use as a biofuel made oil palm the most expansive crop in Indonesia. One of the oldest and largest palm oil producing regions in Indonesia is the Riau province on Sumatra. Using over 21% of the total land areas in Riau, it provides a good opportunity to study effects of long term land conversion on the local rural economy. By using satellite images and GIS methodologies in combination with grassroots-level fieldwork, and economic analyses, we are evaluating the direction and extent of land conversion processes caused by large scale plantations in general but caused by small scale migrants and local people in particular. Oil palm has become a small scale crop, as our economic analyses show. Local people increasingly seem to convert their food cropping land into oil palm plantations, while migrants and displaced people form an uncontrollable and fast growing group of people without land resources, who move into the last remaining "unused" protected forest areas, such as the Tesso Nilo National Park and the ecologically vulnerable peatland forests along the coast with its huge carbon sinks. This poses enormous challenges for sustainable development, especially since the government has recently given out licenses to a large scale timber plantations to convert peatland forest into timber plantations. This causes severe peatland subsidence, of which the socio-economic and environmental effects are the focus of current study in order to provide data for an integrated land use planning for the provincial government in a context of pressure on remaining land resource base caused by large scale land acquisitions and changing population dynamics.



Paper Title: An alternative definition of sustainable development based on capitals  
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### **Considerations on a Sustainable Development alternative definition**

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The 1987 Brundtland definition on Sustainable development, SD (Brundtland 1987) contained three important ideas: development based on needs, intra-generational equity and the inter-generational equity. At that moment, that definition was a novelty; not because of the intra-generational equity, but of the intergenerational one. The novelty also laid in needs, as they put people in the center and not an ambiguous progress.

Since then, the world and the humanity have changed a lot and now, the development Brundtland defined is no longer sustainable because the environmental, social and economic impacts that the meeting of our needs is carrying. A new sustainable development definition is required that takes into account the sustainable use of resources. In this sense a lot of efforts have been done by researchers, economists (IISD 2010) (Rassafi 2006). A new model could chart a development path that truly is concerned with equity, poverty alleviation, reducing resource use, and integrating economic, environmental, and social issues in decision making. The opportunity is ripe to move beyond incrementalism to real systemic change. This communication tries to join to all these efforts and offer a definition of sustainable development based on capitals. This communication is based on the previous work developed by the Unesco Chair on Sustainability (Universitat Politècnica de Catalunya, Spain), a group of researchers and practitioners that for a long time have been thinking, researching, teaching and practicing in terms of sustainable development (Xercavins et al. 2005)(Portal de Sostenibilidad 2012). The work has been followed and enriched by the Research Group on Industrial Ecology (Instituto Politécnico Nacional, Mexico) in a theoretical approach.

The earlier concept of SD is no longer sustainable. Why? Mainly, because the Brundtland definition is centered in needs. Needs cover a very wide range: food, clothing, shelter, sexual activity, knowledge, affection, information, recreation, range, spirituality, etc. Human needs are not objective, they depend on the person, the same object or capacity may be “felt” by one person as a need and not by another one. Needs also depend on the historical moment: certain things can be perceived as a need (e.g. a cell phone) while in other times they weren’t. On the other hand, needs are insatiable, because when we meet a need, then we discover new needs to meet. Also, as needs are very different depending on the region one lives, it is difficult to establish which needs of the population should be met and which shouldn’t. This last aspect sets out a problem for the Brundtland definition itself: how could social equity be put into practice if it’s not possible to decide which population’s needs should be met?

Another aspect of the unsustainability of Brundtland definition is caused by the accelerated use of resources and the impacts in Earth that the meeting of our needs is bringing. The global ecological footprint in 2007 was 2.6 global hectares per capita (National Footprint Accounts 2009 Edition: November 25, 2009), a value that exceeds 44% of the Earth's biocapacity. Also Climate Change shows us that this style of living and rate of consumption will lead to the destruction of our planet. Therefore it is necessary to redefine SD concept so that is genuinely sustainable development. This new definition cannot be based on an infinite and subjective concept –needs-, but on a countable and objective one-the capitals available-. These capitals are: Natural capital (natural resources, biodiversity, etc., or the ecosystem and its services), human and/or social capital (knowledge, skills, multiculturalism, cohesion, participation, etc.), economic capital (financial, infrastructure, etc.).

The proposed definition is: “Sustainable development is the kind of development that that uses the available capital in the present without compromising the ability of future generations to use the same capital.”

In order to move towards SD is important to know the path that leads to it. One important path is SD

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criteria, which set the direction to follow. Some of the SD criteria are:

For materials: **Closed loop systems, Dematerialization, Resource optimization, Reusing & Recycling, Technology innovation, Pollution reduction, Water quality protection, Hazardous substances reduction**

For Energy: Eco-efficiency, renewable energy

At the economic level: Internalizing Externalities, Economy Diversification, Reduction in Environmental Costs, Investment in CSR and quality, Economic benefit for selling waste, Efficient Technologies

At the social level: Resource distribution, Creating new jobs, Increasing quality of jobs, Decentralized technology, Increasing local social capital, Promoting networks, Promoting technological development and education

At the level of values: lower requirements, Giving value to diversity, intergenerational vision.

While sustainable development is intended to encompass environmental protection, social equity and economic growth, over the past 20 years it has often been compartmentalized as an environmental issue (IISD 2010)

In very few years the clear evidence of consumption that humanity itself is making the Earth's resources (eg through the ecological footprint) and the impacts that human behaviors are causing on our planet (eg through climate change) led to realize that the concept of DS was not sustainable, as it was defined.

"Sustainable development is the kind of development that meets the needs of the present without compromising the ability of future generations to meet their own needs."

## REFERENCES

(Brundtland 1987: <sup>1</sup> Our Common Future, Report of the World Commission on Environment and Development, World Commission on Environment and Development, 1987. Published as Annex to General Assembly document A/42/427, Development and International Co-operation: Environment August 2, 1987. Retrieved, 2007.11.14

International Institute for Sustainable Development (IISD) (2010). Sustainable Development:

From Brundtland to Rio 2012. Background Paper\*prepared for consideration by the High Level Panel on Global Sustainability at its first meeting, 19 September 2010. Disponible En [http://www.un.org/wcm/webdav/site/climatechange/shared/gsp/docs/GSP1-6\\_Background%20on%20Sustainable%20Dev.pdf](http://www.un.org/wcm/webdav/site/climatechange/shared/gsp/docs/GSP1-6_Background%20on%20Sustainable%20Dev.pdf)

(National Footprint Accounts 2009 Edition: November 25, 2009)

Portal de Sostenibilidad, <http://portalsostenibilidad.upc.edu/>

ROBINSON, j. Squaring the circle? Some thoughts on the idea of sustainable development. Ecological Economics

Volume 48, Issue 4, 20 April 2004, Pages 369–384

(Xercavins et al. 2005)

Paper Title: The sustainable urban development in European Union: a report on indicators and assessments

Track Title: 5a

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Key words: urban sustainability, sustainable development, governance, environment, indicators, European Union, local policies, planning, institutions, assessment tools

Integration of environment in urban policies is arisen under multiple forms for more than a century. At the beginning, it was only a question of emphasizing the living environment. For around thirty years, the questions linked to urban environment are more connected to economic growth which characterized the twentieth century and the impact it had on environment. We arrived, in 1987, at the institutionalization of the "sustainable development", concept with environment as a main element in the same way as economy and social well-being even if the same concept was evoked from the beginning of the same decade. The governance is considered as the fourth element of sustainable development but its place is just as much dominating as far as it is connected to the politics itself acting on the three main elements of the Brundtland report definition.

However, all the cities do not act in a simultaneous way whether it is on the temporal level and of the general action with visible significant differences. Some cities integrate "eco-districts" or "sustainable districts" into their planning policies. Some others bet on the participation of their inhabitants or prefer the environmental performance, for example, by public transportation development, waste recycling or energy efficiency all that with the aim of improving quality of life of the inhabitants. It could be also in the optics of an efficient political communication with the purpose of making sustainable development, an electoral argument. Local representatives would like to demonstrate that a city is active in term of urban sustainability although it often involves considerable differences between rhetoric and reality. Considering all options, indicators are probably the most significant revealing elements because we could achieve sustainability by general policies but also sector-based policies. We measure it in European Union scale where some cities late set up the sustainability with regard to the ones in the North of Europe.

We have chosen many indicators for fifty-three cities of more than 400 000 inhabitants in the aim to estimate the political action, political characteristics and environmental results of these last ones but also, at the same time, to observe the territorial disparities about urban sustainability in Europe, essentially in the former Europe of fifteen countries.

Finally, we could gather these cities as far as their sustainable development policy is concerned, in the same way of other rankings established by environmental or economical organizations in different countries as *Sustainlane* in United States, *Forum for the Future* in United Kingdom, *Corporate Knights* in Canada, the *Australian Conservation Foundation* in Australia or the *Economist Intelligence Unit* and *Siemens* about European capital cities.

Those indicators correspond to the action of cities in favor of sustainability and results of cities about some environmental or sustainability themes which sometimes correspond to diverse logics often independent from the political action. Although several methods are feasible to estimate the action of cities, results could be really different from one method to another one. It is however necessary to underline the difficulty as far as the choice of indicators is concerned which could return these risky interpretations. We opt for qualitative indicators (binary data), that is to say, if one city has implemented some policies like, for example a local agenda 21, an air quality policy, a sustainable urban area or a green strategy. We also choose quantitative indicators (statistical data) like, among other things, local transportation fees, solid waste recycling, annual number of pollution days or number of representatives by inhabitants.

After that, we develop statistical treatments about all data concerned, like Principal component analysis (PCA), Correspondence analysis (CA) or Classification, all these methods to gather cities by their profile concerning sustainability. After this stage, an overall ranking linked to results on all indicators couldn't be the best option because qualitative and quantitative data are difficult to compare and the main purpose of this work is to modelize the European sustainable city through different profiles. Nevertheless, we try to develop a sustainability index, involving some indicators in a sector-based approach.

Through this communication, we would like to show disparities concerning sustainable urban development on the national, regional and international scales with European examples. In the same way, the comparison or the evaluation sustainable urban development policies can give contradictory results because dependent on choice of indicators and on methods of analysis. We can notice that voluntarism is more consequent in most populous cities because of a higher exposure but the

sensitivity concerning environment and sustainability is the result of geographical and above all, political arguments. We observe that the geography of sustainable urban development in Europe doesn't correspond to a regional or cross-border reason but often corresponds to the main political orientations or sensitivities of mayors and local elected representatives although links between national and local level seem to be obvious in some cases.

Why using these methods and why evaluating cities? We can answer in the following way: we have a global competition between cities and confirm this fact in a more local scale. Being first or well-considered concerning sustainable development or action for the future is always a real argument of attractiveness for any city. An assessment such as this could be a tool for cities to develop and improve themselves in all fields of sustainability. They would observe sectors where they are weaker than others and where they have to act to become "more sustainable" or "greener". This "tool" could help local organizations or more generally, all scales of power, even international in this case. It mainly concerns European Union which skills are really substantial and beyond elaborating reports about sustainability in general or sustainable urban development, could regulate state, regional and cities policies in this field, in harmonization with its main directions. It could strengthen cooperation and interaction between different governance scales in the way of increase urban sustainable development policies, as a major topic.

Paper Title: The cultural dimension of sustainability food labels  
Track Title: 4d Consumption and Lifestyles  
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### Abstract

Consumers have the power to drive major social changes. Transition to a greener economy cannot be pursued against consumer's will. In order to do so, it is necessary to develop specific tools that allow the inclusion of sustainability as a key decision variable of consumer's choices.

The agro-food industry is a sector of significant economic and political importance. As a result of the intensification of production in the last century, food production has been continuously increasing the pressure on the environment. Food constitutes an important and indispensable group of consumer items that are produced in a complex system made up of many processes in several supply chains. These processes require the input of scarce natural resources and cause significant environmental impacts. Agri-food systems are complex, combining human and biological elements that link together diverse people, places and processes through multiple product flows and intermediaries.

How can we transfer this information into the mind of consumers? How can consumers use this information in their individual decision making processes?

The starting point for this paper is a literature review on food supply management, ecolabelling and sustainable consumption focusing in the interaction between these three scientific areas. Notions of environmental history are used to enlarge the context of the analysis.

The paper discusses the feasibility of using eco-efficiency indicators, translated into product labels that would be used by consumers to reduce their daily environmental impacts. There are significant limitations on the use of eco-labels, solely based on eco-efficiency indicators as a measure of sustainability of a specific product. These indicators do not account directly for environmental effects outside the boundaries of the supply chain, resource availability and that they are strongly dependent from the availability and quality of the data required for calculations.

This discussion is particularly important in the case of food. Eco-efficiency indicators cannot be limited to the technological component of food and hardly include other dimensions of sustainability such as economy, social conditions and culture. Transition to a green economy requires the creation and adoption of standardized schemes that translate the complexity implicit in food into simplified labels that help consumers' decision making.

A good food ecolabel must integrate social and cultural visions and should not be limited to a

technological environmental assessment of the food supply chain. This requires skills on the integration of environmental, economic, social and cultural data and to react to the existing trade-offs between the different components of the problem. This holistic ecolabel can only be achieved through integration of expertise from life cycle assessment, impact assessment, nutrition and consumer behaviour.

Paper Title: Large cities and urban transitions:  
local governance and spatial strategies for sustainable environments  
Track Title: 5a Sustainable Cities  
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### 18th Annual International Sustainable Development Research Conference

University of Hull, 24-26 June 2012

Oral presentation

Abstract.

By the beginning of the 21<sup>st</sup> century the continual rural-urban shifts resulted in the situation in which more people live in cities than in the countryside. By 2030 two-thirds of people will live in large cities and densely populated metropolitan areas. Cities are bigger than ever imagined and continue to grow, presenting waves of intra and interurban transitions. Key questions that we seek to answer in this discussion paper include such as what is meant by urban sustainability in the context of the social and urban environmental transitions and geomorphologies. With the current world population predicted to grow by nearly 3 -5 five billion people by the year 2050, demand for resources, including energy, water and food, in cities is likely to further increase the pressure on the ecological foundation of their respective hinterlands and wider areas. UN-HABITAT describes cities as the new locus of poverty. Megacities have emerged across the globe with urban concentration much in excess of the 10 million inhabitants, many over 20 million. These places, and the spaces within them, contain urban transitions that bring about changes in the city, their shape and form, in their governance, new complexities and in the services they provide. They host intense and complex interactions between different demographic, social, political, economic and ecological processes such that the sustainable city is a mere notion. The World Bank Urban and Local Government Strategy (2000) report stated that Cities and towns are not only growing in size and number, they are also gaining new influence. The urban transition offers significant opportunities to improve the quality of life for all individuals, but whether this potential is realized depends critically on how cities are managed and on the national and local policies affecting their development. We discuss the nature of the urban transition in comparative city context drawn from a case study of three megacities from Africa, Asia and South America. We investigate how local governance and spatial strategies can encourage sustainable environments during the urban transition process.

**KEY-WORDS:** sustainable development, megacities, urban transition, sustainable environments, local governance, spatial strategies,

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Paper Title: Decentralised, Global Networks: A framework for multi-scaling education for sustainable development  
Track Title: 3a  
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### Abstract

Globalisation is implicated as a driver of many sustainability issues, but it also changes the way these issues are understood and can provide the tools for addressing systemic problems that have so far eluded smaller-scale approaches to sustainability learning. Certainly, globalisation has a range of implications for the development and implementation of contemporary Education for Sustainable Development (EfSD) including: (1) increased emphasis on the global and intractable nature of many sustainability issues (e.g. climate change, land degradation, poverty) towards a focus on approaches that can effectively link local and global scales; (2) greater access to information and communication technologies that can support information exchange and educational programs across ever-increasing distances; and (3) the development of a broader scope for educational investment from outcomes based around individuals to opportunities for societies and even nations. In particular, an emerging trend has been the application of decentralised, global networks in the development, operation and implementation of EfSD programs. However, there is little documented evidence of the success of such recent approaches or of the inherent barriers and opportunities in scaling up EfSD programs from the local to the global scale. This paper examines quadruple bottom line approaches and theories of scalability in the development of a theoretical framework for organisations and global networks to evaluate the strategies for, and outcomes of, EfSD programs delivered through decentralised, global networks.

This paper is written as the precursor to the collection of data via case studies, key informant interviews and surveys. Data collection will commence in early 2012 and build upon the research to date. Research results will form a main chapter in the submission of a Thesis in fulfilment of a Doctorate of Philosophy.

### Preferred Presentation Format: Oral

Paper Title: 'Delivering sustainability – the role of environmental management plans'  
Track Title: 3e  
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18<sup>th</sup> Annual International Sustainable Development Research Conference University of Hull, 24-26 June 2012  
Preferred form of presentation: oral

### Abstract:

Environmental impacts of investment projects (e.g. major infrastructure developments, mineral extraction proposals) are currently studied and mitigated from two distinct perspectives: ex ante through the environmental impact assessment (EIA) process and after project implementation through the use of environmental management systems (EMS). This double-perspective creates a discontinuity in the way environmental impacts are dealt with but there is no significant reason why this situation should remain sub-optimal as EIA and EMS are both environmental protection tools with

complementary purposes: whilst the goal of EIA is to anticipate and mitigate the environmental impacts of proposed new projects at the planning and design stages, an EMS can help organisations to effectively manage the day-to-day environmental impacts arising during the construction, operation and decommissioning of such projects. By supporting a systematic approach to the identification and evaluation of impacts, both tools can ensure that resources are focused on those impacts deemed to be “significant”. Used effectively and in an integrated manner, they can ensure the main environmental issues are identified at an early stage in project planning and are systematically addressed throughout the project life-cycle.

Environmental impact assessment (EIA) is an important procedure both nationally and internationally for ensuring that the likely effects of new development on the environment are fully understood and taken into account as part of the decision making process before the development may proceed. EIA (or ESIA as it is also referred to) is legally required in most countries (including the UK) and has been the subject of a wide range of legislation, guidance, academic research and legal judgements since its origins in the 1970s. There is no formal requirement for an environmental management plan (EMP) within EIA legislation in the UK, but they are increasingly being used as a way of ensuring that mitigation measures proposed in the ES are implemented on the ground (IEMA, 2008, 2011). Marshall (2004), who coined the phrase ‘EMS-lite’ to describe EMPs, also suggests that, by focussing on what is significant, they can act as the ‘linking interface between the formal certified EMS and the EIA/project development’ (p. 141).

This presentation considers the origins of the concept of EMP. It briefly considers their effectiveness in delivering environmental protection through reference to a case study and their current usage. It concludes by reflecting on how EMPs can form the key link in extending the management of the impacts of development from assessment through to management and how this could be further enhanced.

#### References:

IEMA (2008) Environmental Management Plans. Practitioner Best Practice Series Vol 12., UK  
IEMA (2011) Special Report – State of Environmental Impact Assessment in the UK. [www.iema.net](http://www.iema.net)  
Marshall, R (2004). Can industry benefit from participation in EIA follow-up? The Scottish Power experience in Morrison-Saunders, A and Arts, J (eds) (2004) Assessing impact: handbook of EIA and SEA follow up. Earthscan, London

Paper Title: ‘Zones of Intermediality’  
as analytical and theoretical tool to examine large-scale land acquisitions.  
Track Title: 5f Land Acquisitions  
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International actors increasingly work through global structures and deploy discourses to access, acquire and exploit vast tracts of arable land in Africa for various purposes (e.g. agricultural production, bio-fuel, multinational mining and conservation). At the site of such projects, tensions emerge between divergent international and local conceptualizations of development, history, heritage, livelihood security, and sustainability.

In this paper, the authors propose an innovative theoretical model ‘zones of intermediality’ to address the above problematic, focusing specifically on how diverse, culturally-informed stakeholder approaches to the environment and land use come together on the same playing field. ‘Zones of intermediality’ are physical and ontological grids where land claims are mediated, legitimized and/or defended by various stakeholders - company, government official, local elder, NGO, etc. ‘Zones of intermediality’ may be triggered by any number of discursive and non-discursive factors. We approach ‘zones of intermediality’ in two principal ways:

1. *land access and legitimization*: by investigating media used by stakeholders to legitimize their land claims;
2. *embodied valuations*: by analysing how different land and livelihood valuations are mediated by cultural paradigms;

The first approach focuses on historical and contemporary processes of inclusion/exclusion (dispossession or access restrictions) from land as legitimized through media/processes of mediation. Media plays an important role in legitimizing high impact land projects, and the depiction of local stakeholders as the main degraders of the environment in mainstream media is a powerful discourse of legitimacy. The authors aim to situate 'land degradation' within specific historical, cultural, ecological, political-economic and discursive contexts.

The second approach concentrates on the breakdown - where each actor in the 'zone of intermediality' might use a similar language, but mean something different. This is predicated on the hypothesis that different stakeholders approach notions of development, wealth, land use, labour, 'sustainability', and heritage differently. Where, why and how does a break point (conflict) emerge within the context of (inter-)national – local interaction? We aim to adapt this model to applied development aims by showing how and why different stakeholder approaches to land are mediated by (non-)discursive cultural paradigms.

In sum, intermediality has a dual interest - as a tool wherein media is deployed to achieve certain ends, be they economic, political, cultural and/or charitable, and as a mirror of the wider cultural environment.

**Sandra J.T.M. Evers**, Ph.D. (Amsterdam 2001), is associate professor and senior researcher at the Department of Social and Cultural Anthropology, VU University Amsterdam. She specialises in Africa and South West Indian Ocean studies, with a particular focus on Madagascar, the Seychelles and Mauritius. Dr Evers' principal areas of research cover the anthropology of children, (forced) migration, slavery, memory and cognition, frontier societies within the context of globalisation, natural resource management, poverty and sustainable development. She is Programme Director of the NWO-Wotro funded Integrated Programme (September 2011- September 2015) "Development as a Trojan Horse? Foreign Large-scale Land Acquisitions in Ethiopia, Madagascar and Uganda" ([http://www.wotro.nl/nwohome.nsf/pages/NWOP\\_8CJG5H\\_Eng](http://www.wotro.nl/nwohome.nsf/pages/NWOP_8CJG5H_Eng))

Sandra Evers is also chair of the International Anthropology of Children Working Group which convenes in monthly seminar meetings (<http://www.anthropologyofchildren.net>)

More information: <http://www.fsw.vu.nl/en/departments/social-and-cultural-anthropology/staff/evers/index.asp>

The research projects within the research programme "Development as a Trojan Horse? Foreign Large-scale Land Acquisitions in Ethiopia, Madagascar and Uganda":

- Caroline Seagle (since September 2011): "The mining-conservation nexus: New regimes of 'sustainable development' in Madagascar".
- Mijasoia Miandravola Andriamarovololona (since September 2011): "The power configurations of climate policy: REDD (Reducing Emissions from Deforestation and Degradation) in Madagascar".
- Theodoros Woldegiorgis Atreso (since September 2011): "Foreign large-scale food production and local dislocation in highland Ethiopia".
- Josh Maiyo (since September 2011): "Chinese "Eco-Cities" in Uganda's Lake Victoria Free Trade Zone (LVFTZ)".
- Affiliates PhD candidate Davide Cirillo: "Chinese Migrations and Agricultural Investments in Africa, particularly Senegal".
- Affiliated Postdoc Froukje Krijtenburg: "Talking Land Sale: Stakeholders' Mediations of Free Prior and Informed Consent in Foreign Land Acquisitions in Kenya".



Paper Title: Era of Shaky Sustainability Policies,  
A System Dynamic view on trend of future policies  
Track Title: 1a  
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## Introduction

We live in an unsustainable era. Naming just one problem, greenhouse gas (GHG) emissions resulting from non-renewable energy resources, especially fossil fuels, are rapidly changing the climate and consequently life on planet earth. Coupling the environment and economy can prevent more severe problems. Reciprocal benefits presented in Figure 1 can hold both economy and ecology in a stabilized and long-lasting position.

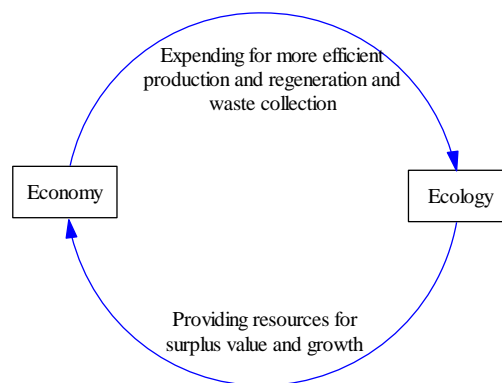


Figure 1: Coupling of Environment and Economy

For years, individuals, firms, governments and international organizations put a lot of effort into developing and adopting sustainable technologies, policies and behaviors. Despite all these efforts results are not always satisfactory. As an example, Canadian government is formally withdrawing from the Kyoto protocol. This was the motivation for writing this paper which tries to understand the dynamic in which the decision has been made in spite of awareness of sustainability problems. The rationale behind the decision, from Canadian government viewpoint is that "Canada's obligations under Kyoto would cost \$13.6bn. That's \$1,600 from every Canadian family" (Kent, 2011).

Policy actions trigger series of events and feedbacks that sometimes undermine the policy over time and even exacerbate the original problem. For example, Kyoto protocol as a policy action was supposed to make a difference in GHG concentration due to series of incentives and change of behaviors. However, it was not a complete success and in cases like Canada and USA we witness a "policy resistance" (Sterman, 2000).

## Methodology

What is behind that resistance and what are the consequences? In this paper, we analyze the root cause of the improper coupling from a system dynamics perspective and attempt to measure the effect of different scenarios and solutions to make the coupling work.

System dynamics is an approach to understand the behavior of complex systems over time. It deals with internal feedback loops and time delays that affect the behavior of the entire system. Some characteristic of sustainability policy context make SD a good method of analysis such as complexity of the environment in which unsustainability problem arise and in which policies are made, need to persuade different stakeholders and need to experiment and the measuring cost and effects of the proposed (Ghaffarzadegan et al., 2011).

System dynamics models are able to include feedback in and are easy and not costly illustrate the sources of policy resistance in the environment. Moreover the system dynamic approach, facilitate learning through extensive experiments and bring different stakeholders' incentives in one model. (Ghaffarzadegan et al., 2011).

## Cause and Effect Mechanism of Moving toward Sustainability

Economic growth and rise in production and consumption increase the amount of harm that human civilization cause to the environment and decrease the level of non-renewable natural resources. Consequently, the knowledgeable monitoring members of society initiate notifying about the consequences such as pollution and depletion. Dissemination of this information over time creates consensus about the severity of environmental

problem and leads to commitment to do counter-action. The commitment with delay results in some sustainable solutions and diffusion of the solutions can lead to less consumption, less harm to the environment. The above statement has been modeled by balancing loops of B1 and B2 in Figure 2. This is the classic mindset behind current sustainability issues and mechanism of coupling.

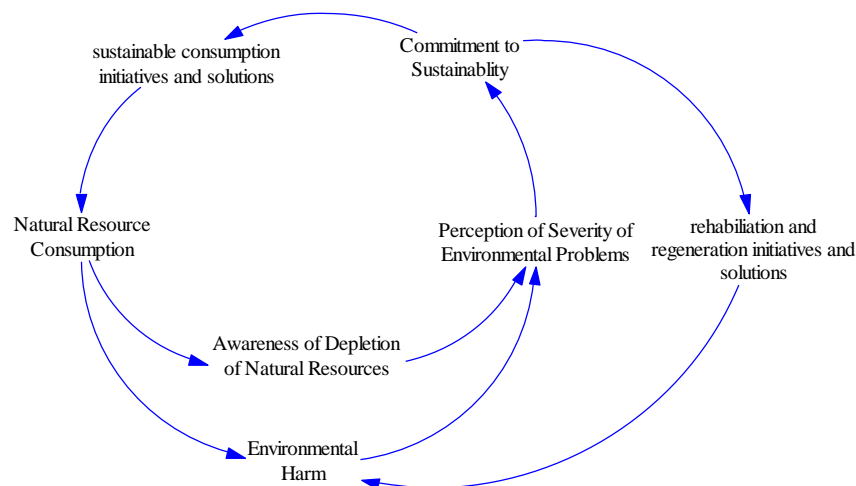


Figure 2: Casual loop diagrams behind spread of sustainability

### Resistance: the forgotten mechanism

Researchers have reported resistance to change of behavior, accepting and implementing sustainable solutions in different forms. In the individual level we know that People don't want to follow the proper practices, even though they are fully aware of them and why they should logically follow them. In organizational, sectional and societal level resistance also exists. Arbuthnott et al. (2011) illustrated how renewal toward sustainability may be threatened by responses of established firms operating within traditional non-sustainable industry. Similarly, Harich (2010) showed the importance of dominant agent goals that conflict with the common good changes and showed change resistance is the real problem to solve. In agreement with the mentioned arguments about resistance, we model the future of sustainability coupling with eyes on the issue of cost pressure. Our perspective is originated from the Canadian withdrawal and its *raison d'être*. We add the cost pressure mechanism in the form of balancing loops of B3 and B4 (Figure 3).

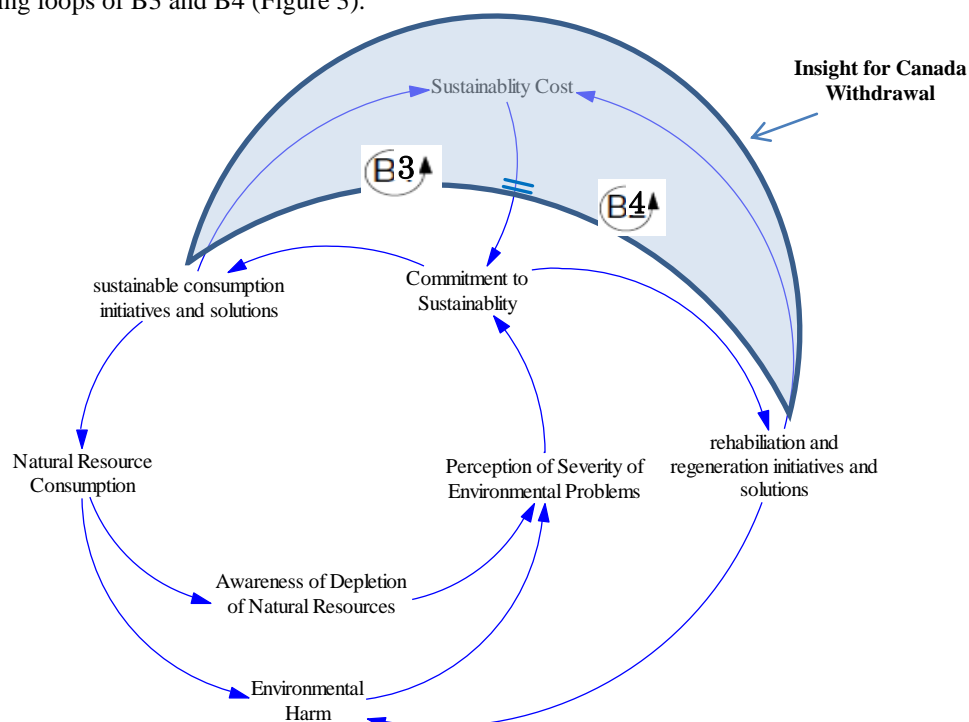


Figure 3: Balancing casual loop diagrams (resistance mechanism)

### Simulations and Results

In this paper, we run three simulations. First, the classic view of adopting sustainable solutions and policies by societies; second, adding change resistance mechanism and the effect of cost pressure on commitment and third adding a more holistic measure including both economic and environmental issues (instead of just looking on economic growth and feasibility) and its effect on accepting sustainable policies and initiatives. The classic view makes balance between consumption and regeneration in long-term due to spread of sustainable solutions and also increases in the share of knowledge-based economy. The change resistance mechanism prevents the classic view and makes societies to take a shaky position about commitment to sustainability. Initially they highly commit to counteractions, however after a while take a lower level of commitment due to cost and effect on economic growth and welfare, meanwhile the problem gets worse and again the loop will be repeated until we consume all the natural resources and destroy the ecology for the sake of economy. The third run with new paradigm can bring balance between consumption/harm and regeneration/rehabilitation and makes the coupling work. The model and the results of simulation are presented in Figures 4 and 5.

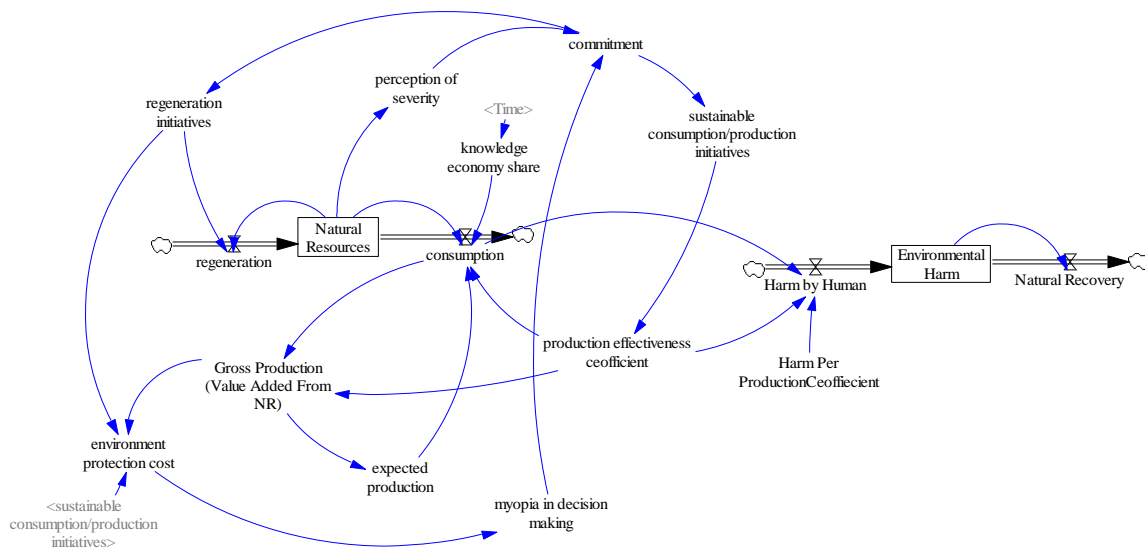


Figure 4: The Simulation Model

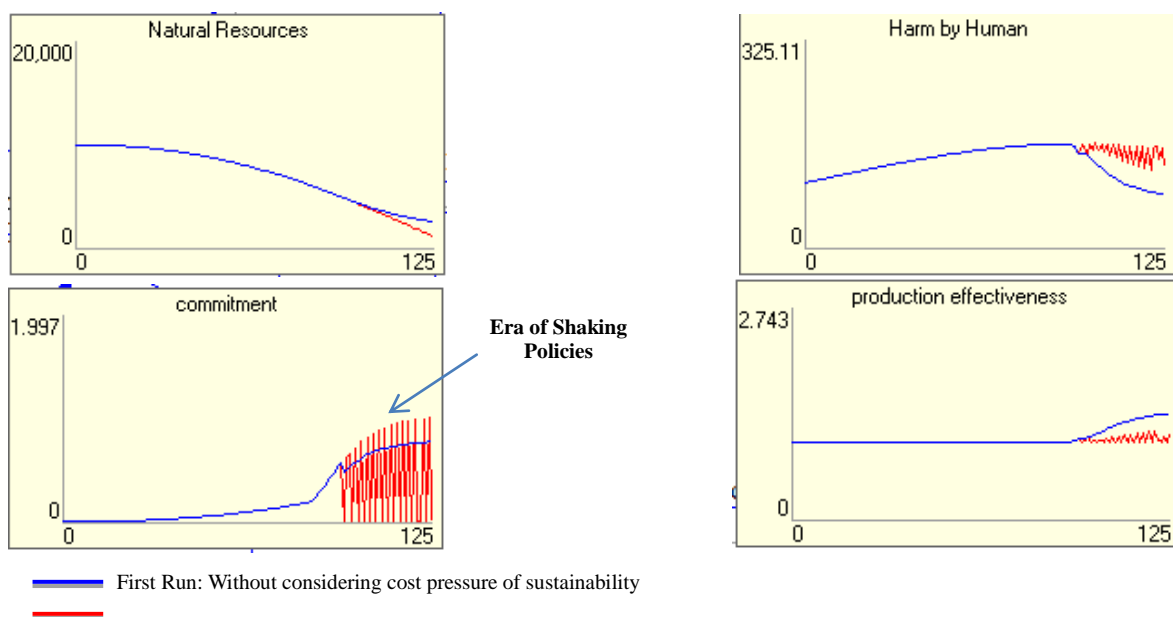


Figure 4: Results in two runs

### Conclusion and discussion

The simulation result shows that instead of focusing our activities on developing more advanced sustainable technologies and solutions, we should be more concentrate on changing paradigm of governmental and individual decision making. Replacing a combined measure which considers both environmental sustainability and economic growth to the current thirstiness for economic growth is a priority. Without changing the reference points the coupling is temporary and the economy outweighs the ecology and until that decisions like Canadian government would be common which we call Era of shaky Sustainability Policies. In other words, if we want to prioritize between two major types of environmental behavior, curtailment and efficiency increasing (Black et al., 1985), the earlier is more important and more efficient. Curtailment is associated with discomfort for example not using air-conditioner in summer (Gardner and Stern, 2002) and less cost due to less consumption while efficiency increasing is associated with cost for substituting old technologies with green solutions. This conclusion is a good starting point for following debate on Rio+20.

### References

- Arbuthnott, A., Eriksson, J. & Thorgren S. (2010). Reduced opportunities for regional renewal: The role of rigid threat responses among a region's established firms, *Entrepreneurship and Regional Development*, 23(7-8): 603-635.
- Kent P., Environment Minister, BBC News, <http://www.bbc.co.uk/news/world-us-canada-16151310>. Retrieved: 13 January 2012.
- Black, J. S. , Stern, P. C., & Elworth, J. T. (1985). Personal and contextual influences on household energy adaptations. *Journal of Applied Psychology*, 70, 3-21.
- Sterman JD. (2000). *Business Dynamics: Systems Thinking and Modeling for a Complex World*. Irwin/McGraw-Hill: Boston, MA.
- Gardner, G.T. & Stern, P.C. (2002). *Environmental Problems and Human Behavior*. Pearson Custom Publishing: Boston, MA.
- Ghaffarzadegan, N., Lyneis, J. & Richardson, G. P. (2011). How small system dynamics models can help the public policy process. *System Dynamics Review*, 27: 22-44. doi: 10.1002/sdr.442
- Harich, J. (2010), Change resistance as the crux of the environmental sustainability problem. *System Dynamics Review*, 26: 35-72. doi: 10.1002/sdr.431
- Meadows D. H., Randers J. & Meadows D. (2004). *The Limits to Growth: the 30-Year Update*. Chelsea Green: White River Junction, VT.

Paper Title: The governance of the transition to a low carbon economy/society: What roles for public, private and civic actors?  
Track Title: 3b  
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### Abstract submitted for the 18th Annual International Sustainable Development Research Conference, University of Hull, 24-26 June 2012.

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### ABSTRACT

Employing a multi-disciplinary approach, this paper combines concepts from two bodies of literature. Drawing on political science and public policy analysis, the first is concerned with the notion of governance and modes of governance. The second, located within management studies and business ethics, involves the notion of corporate social responsibility. Specifically, the paper explores the roles of, and relationships between, three sets of societal actors (business, government and the third sector) in the area of climate change public policy. The paper takes as its focal point the Copenhagen summit

in December 2009. The primary research conducted for this paper, a large scale postal survey of UK-based firms, collected data to answer the following questions. What role do UK-registered firms see themselves as having with regard to challenge of climate change in comparison to other policy actors? Did the surveyed firms participate in national and international climate change policy formulation with regard to COP 15 (and how)? What were their main objectives with regard to national and international climate change policy and COP 15? Were these objectives met? What were their assessments of COP 15 in terms of the content of the policy that emerged and the processes by which it was formulated? The data suggests that the majority of those surveyed were able to articulate clear objectives and had taken steps to try to shape the policy but that a significant percentage were dissatisfied with the processes and outcome of COP 15. Many of the respondents recognised a business case for a low carbon economy and preferred a mode of governance that offers a well-designed, clear, and long-term policy and legislation for investment purposes. Many pointed to the deficiencies of the governance process but acknowledge the complexity of the issues and the difficulty of reconciling so many interests.

Paper Title: Scientific Uncertainty and Environmental Justice: The Controversy over Water  
Resources Development in Taiwan

Track Title: 1b

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### Abstract

How do issues of environmental justice play out in conditions of scientific uncertainty and cultural diversity? This paper use the case of the Tseng-Wen Reservoir Trans-basin Water Diversion Project in Taiwan to explore how policy stakeholders and local residents perceive the distribution of interests, the environmental risks of the project, and the policy implications of local action. The research methods adopted include documentary analysis and in-depth interviews. It shows multiple perspectives of stakeholders on the project, various knowledge claims among experts of different disciplines, and conflicts between local knowledge and experts. Authorities have framed the project as either a water supply effectiveness issue or an economic development issue. However, environmental groups doubt the necessity of the project; that it involves extensive self-interest and bribery, limitation of experts' thinking on water resource development, and the problem of monetizing water. Environmental groups also challenge the credibility of the environmental impact assessment (EIA). It highlights the problem of lack of recognition of people and place. The aboriginal tribe's unique cultural meanings, invisible cultural assets, and their integrated relationship with nature are excluded from the EIA report, which lacks fully informed consent and local residents' substantial participation in the decision-making process. The project involves scientific controversy as well as the unpredictable and irreversible impacts on the environment which cannot rely upon experts and technocracy only. Local particularities and lay knowledge need to be included in policy-making. This paper argues for the need of early involvement and public deliberation on water resource planning, and for seeking consensus through continuous intercultural and interdisciplinary dialogue.

Keywords: environmental justice, water resource governance, environmental risks, public participation, environmental impact assessment

Paper Title: Disabled People as Environmental Citizens: Implications for Environmental and Social Justice  
Track Title: 1b  
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#### Oral presentation

Conceptualised as an issue of social justice, disability should be a relevant concern for those involved with environmental justice agendas. However in the current literature, disability is seldom considered beyond issues of environmental damage or disaster, with disabled people often described as victims in these contexts. Taken alone, this focus draws attention away from the large heterogeneity within and between individuals and groups who might be categorised as disabled.

At the same time, in the developed world, prevailing neo-liberal ideology means that social policies often focus on individual responsibility, for example regarding measures undertaken towards sustainability. Citizenship is therefore broadly understood in terms of obligation and citizenship rights become contingent on active participation.

In this context, disabled people's status as full citizens may be threatened by barriers to participation or their agency may be undermined by a policy focus on disability that sees disabled people as a potential target for other people's citizenship duties. This risks leaving disabled people further disadvantaged in the transition towards a more sustainable society, and also means an opportunity to enable disabled people to reduce their own environmental impact may be missed.

Exploring the relationship between disability and environmental citizenship from an environmental justice perspective can help to illuminate such issues and their potential solutions. It can also reveal potential areas of tension between aims of sustainability and accessibility. These may occur where the environmental implications of meeting disabled people's needs have not been considered or because society's role in creating inaccessible spaces or practices of sustainability has been neglected. Finally, investigating these issues can enable an exploration of how disabled people might understand their own agency in relation to such matters.

Although largely theoretical, this paper will also provide illustrative examples from data generated by a very small-scale qualitative pilot study in the UK, using oral and visual methods, which attempted to explore some of these issues with disabled people who are already environmentally active.

Paper Title: An ethical framework for agricultural adaptation to climate change in the Mediterranean region.  
Track Title: 2c  
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#### 18th Annual International Sustainable Development Research Conference

##### Abstract

**BACKGROUND.** In the coming decades, the Mediterranean region is expected to experience various climate impacts with negative consequences on agriculture, among which uneven reductions in agricultural production. In particular, it seems likely that the impacts of climate change and variability will be heavier in southern areas (i.e. Middle East and North Africa). This unbalanced distribution of

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negative effects makes agriculture in the Mediterranean region a particularly controversial context, which emphasizes the role and potential of ethical analysis. However, the latter is still infrequent in the current literature on agricultural adaptation to climate change, despite the fact that ethical considerations imply greater legitimacy and can persuade parties with conflicting interests to cooperate more closely on collective actions.

**GOAL.** The aim of this contribution is to develop and justify an ethical approach to agricultural adaptation in the Mediterranean region and to derive the consequent implications for adaptation policy in this region.

**METHOD.** First, we defined and calculated an adaptive capacity index (ACI) for the Mediterranean Region. The ACI is defined by the performance of the agricultural system in relation to six determinants (economic resources, technology, information and skills, infrastructure, institutions, and equity), each associated with two indicators. Secondary data were used to calculate the indicator values. Second, on the basis of the IAC, we clustered the Mediterranean countries in sub-regions, and then provided an overview of the suitable adaptation actions and policies for these sub-regions. Third, we identify the actors involved in agricultural adaptation to climate change, i.e. the subjects of justice. Finally, based on the previous analysis, we put forward an ethical approach to agricultural adaptation, highlighting the implications for the Mediterranean region.

**RESULTS.** The ranking for the total ACI showed a clear divide in terms of adaptive capacity between the North and South Mediterranean countries. The ACI also showed that the North–South divide depended largely on soft determinants (information and skills, institutions and networks, equity) and on economic resources. Instead, from a technological and infrastructural perspective, the difference between North and South Mediterranean countries was less manifest. Therefore, the soft determinants may represent key entry points for increasing adaptive capacity in the South Mediterranean countries. The subjects of justice identified were farmers, producers organizations, national governments, and NGOs and international organizations. The ethical framework, which adopts a liberal perspective, is based on two principles: (i) more advantaged subjects should bear the burden of adaptation (i.e. ability to pay), and (ii) less advantaged subjects should be assured privileged access to adaptations (lack of adaptive capacity). According to this framework, farmers in Northern Mediterranean countries are not morally entitled to adaptation assistance, whereas those of the Southern Mediterranean countries are morally eligible for it. Northern producer organizations and national governments are morally obliged to be contributors, while Southern ones are recipients. Furthermore, adaptation assistance is due to recipient subjects of justice also from NGOs and international organizations in their representative role. Finally, the assistance should be preferably in-kind.

**CONCLUSIONS.** The study shows the critical relevance of ethical considerations when dealing with adaptation in agriculture. In particular, the ethical analysis carried out fundamentally made it possible to identify, in the Mediterranean context, morally entitled contributors and recipients of adaptation assistance. Eventually, we believe that, in regions characterized by high degrees of inequalities such as the Mediterranean basin, ethical considerations might provide reasoned elements for debate among regional stakeholders with regard to the development of an agreed-upon framework to confront agricultural adaptation and devise coherent and sustainable regimes.

Paper Title: Voluntary simplicity and Transition Network: a comparison of narratives, practices and strategies  
Track Title: 3d – Redefining Development  
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**18th Annual International Sustainable Development Research Conference**  
Miller Building, Whiteknights, RG6 6AB, Reading, UK, Tel: 0118 3787496

### **Abstract**

**Background.** There is currently a growing interest among researchers and policymakers in the diffusion of grassroots innovations (GI). GI are “networks of activists and organisations generating

novel bottom–up solutions for sustainable development; solutions that respond to the local situation and the interests and values of the communities involved” (Seyfang and Smith, 2007). GI criticise at least some features of the Western model of development, experiment with often radical social and technological innovation, and develop new systems of provisions that reflect different worldviews and systems of values (e.g. de-growth). Consequently, they represent niches of experimentations that challenge the mainstream regime and aim to foster resilient and/or sustainable alternatives to it. The landscape of GI is characterised by high diversity of local networks with their specific cultural orientations and, also given its relatively recent development, it is fluid and rapidly evolving.

**Problem.** However, the current literature often tends to neglect such diversity, and different local experiences are usually grouped under the same label of GI. While this is motivated by clear commonalities among different networks, there is the risk of masking significant differences and thus to limit the ability to fully understand the GI's i) specific internal dynamics and ii) interactions with the regime. Both these factors can play key a role in determining the GI's chances of success in fostering sustainability transitions.

**Goal.** This study presents a comparative analysis of two GI. The study aims to assess potential differences between the two in terms of narratives, practices and strategies, and to discuss how these influence their internal dynamics and their interaction with the regime.

**Method.** Two Italian GI networks, i.e. a voluntary simplicity network called Bilanci di Giustizia (BDG), and a Transition Network movement, i.e. Transition Network Italy (TNI) were selected. For each network, institutional documents, both printed and in electronic form, were analysed in order to deconstruct the respective narratives, the innovations in practice, and the sustainability transition strategies adopted.

**Results.** The comparative analysis shows that BDG and TNI share significant commonalities both regarding their narrative (e.g. environmental crisis, enhancement of wellbeing), in the innovative practices experimented (e.g. alternative food systems, time banks), and the way they operate (e.g. importance of network, geographical distribution). However, the analysis also shows significant differences, among which the concepts used (sustainability versus resilience), the agents of change identified (families versus communities), and the scale of action (cultural versus practical). These affect BDG's and TNI's different ability to recruit members, and their different degree of openness to collaborations with actors in the regime such as businesses and local authorities.

**Conclusion.** This study shows that a finer grain in the analysis of GI is needed in order to better understand both their internal dynamics and their interactions with the regime. Both these factors are likely to play an essential role in determining the GI's chances of success in promoting sustainable alternatives to the mainstream, and thereby fostering sustainability transitions.

Paper Title: Sustainability assessment for decision-making in agriculture: a comparison of methods

Track Title: 3e

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### 18th Annual International Sustainable Development Research Conference

#### Abstract

For a long time, sustainability assessment in agriculture has focused mostly on environmental and technical issues, thus neglecting the economic and, above all, the social aspects of sustainability, the multi-functionality of agriculture and the applicability of the results. In response to these shortcomings, several integrative sustainability assessment methods have been developed for the agricultural sector. This paper reviews seven of these that represent the diversity of tools developed in this area. This paper develops a framework for evaluating sustainability assessment methods by separately analyzing their normative, systemic and procedural dimensions. The framework is then used to characterize indicator-based sustainability assessment methods in agriculture.

The reviewed assessment methods can be categorized into three types: (i) top-down farm assessment methods; (ii) top-down regional assessment methods with some stakeholder participation; (iii) bottom-up, integrated participatory or transdisciplinary methods with stakeholder participation throughout the



process. The results readily show the trade-offs encountered when selecting an assessment method. A clear, standardized, top down procedure allows for potentially benchmarking and comparing results across regions and sites. However, this comes at the cost of system specificity. As the top down methods often have low stakeholder involvement, the application and implementation of the results might be difficult.

Our analysis suggests that to include the aspects mentioned above in agricultural sustainability assessment, the bottom-up, integrated participatory or transdisciplinary methods are the most suitable ones.

Paper Title: The role of machinery rings in the transition towards increased regional sustainability of agriculture in Scotland.  
Track Title: 5e Agriculture and Regional Development  
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**18th Annual International Sustainable Development Research Conference  
University of Hull, 24-26 June 2012**

**Abstract**

When the concept of machinery rings came to Scotland in the 1980s it was identified as a way to improve efficiencies in farm operations, by providing a system for farmers to share unused capacity of farm machinery with others in their local area. As the system has evolved, the term machinery has come to under-represent the function of the ring and its role in the wider context of farming and rural communities, which now includes labour, commodities and training in its portfolio of services offered. Drawing on transition management theory, machinery rings are examined as an example an emergent transition that may contribute towards the overall sustainability of agriculture at the regional level. Through analysis of data collected by means of key informant interviews and stakeholder focus groups in the north-east of Scotland, this paper explores machinery rings in relation to technical, societal and institutional dimensions at the niche, regime and landscape levels. The importance of collaboration, hybrid actors and network anchoring are also explored in terms of linking niche-level activities with regime level processes. As a form of agricultural co-operative it is suggested that machinery rings not only facilitate valuable vertical integration across the rural economy but they also alter the character and composition of social capital stocks within the rural community. Research presented here is part of the European Commission-funded project 'FarmPath'.

**CALL FOR PAPERS**

Track 5e: Sustainable Agriculture and Rural Development

Lewis Holloway and Kirstie O'Neill  
Department of Geography, University of Hull

**Goals and objectives of the track**

The track aims to provide a forum for discussing a wide range of issues related to sustainable agriculture and rural development in both the Global North and Global South. Amidst rising concerns about increasing human populations and rapid anthropogenic environmental change, debates about food security and food sovereignty at scales ranging from the very local to the global are becoming increasingly urgent. The track aims to foster discussion of different perspectives on these issues, which might centre on topics such as the effects of trade liberalization, reform of agricultural and development policy frameworks, the possibilities and problematics of highly technological responses such as GMOs, the promises held out by 'alternative' approaches to agriculture such as organic production or 'appropriate technologies', and perspectives which refocus attention on issues such as food or land redistribution, food justice and democracy, and social equality. Situating agriculture into a wider context, the track also provides an opportunity to consider the role of farming in sustainable rural development processes, examining the potentially symbiotic and potentially tense relations between

on the one hand farming practices and food economies, and on the other hand integrated rural development with its need to negotiate the complex relationships between economy, society and environment. Included here is consideration of the sustainability or otherwise of food production-consumption linkages, at local, national and global scales.

Contributions are sought from the followings areas

- \* Approaches to food security and food sovereignty
- \* Approaches to food justice and food democracy
- \* Agricultural technologies and sustainable food production
- \* 'Alternative' agricultures and rural sustainability
- \* Sustainability and the reform of agricultural and rural development policy frameworks
- \* Sustainable rural development and its relationship with agriculture
- \* Sustainable food production-consumption relationships

Paper Title: Dynamics of a population under different energy scenarios

Track Title: 2b

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Energy security has gained prominent attention from both researchers and policy makers while modelling sustainable development has become a major concern. An increasing number of authors suggest that mankind would possibly face an upcoming energy crisis, a few of them bringing our societies back to the Middle Ages. In this paper, we study the long-term implications of different energy scenarios on a set of 3 parameters: demography, life expectancy and biodiversity. Technology invaded our living, with breakthroughs in medicine or nutrition; it resulted in a recent improvement of our longevity during the past century, meanwhile a dramatic reduction of biodiversity occurred. However, this trend may not be set in stone, and the limits set in our genes may apply. Other indicators - such as sport performances - also revealed an S-Shaped pattern that is much likely to occur in these 3 parameters, as a consequence of the 'saturation' of our environment. To test each of these dynamics, we carried out numerical simulations to monitor the spatial and temporal development of individuals using finite-size lattices. Each individual included in the simulation can perform a set of 4 actions: move, reproduce, do both or do nothing. They consume fossil fuel or renewable energy (according to their profile) and food. A relationship between their consumption and the biodiversity is introduced at two scales: local and global. The dynamics of the 3 parameters were monitored according to different initial conditions in straight-forward runs of the simulation. An alternative approach was defined, with the use of a multi-agents methodology and the introduction of cooperation and competition. Different growth patterns were observed: limited S-Shaped or exponential growths. In all cases the patterns included an overshoot, with the return to various thresholds for the 3 parameters and in some cases, a sustainable development is possible. Other scenarios exhibited a complete collapse of the human demography and a rarefaction of fossil fuels and biodiversity. While we emphasize both the reductionist approach we used and the exclusion of any future breakthrough that would permit to

overcome the overshoot, this gives us an indication to select the conditions and actions that best prevent the collapse resulting from it. Simulation fine tuning also allow for the estimation of how much those results differ due to cooperation or competition. Finally, the various patterns observed meet the present perspectives that arose in the modern scientific literature.

Paper Title: Developing tools for low-carbon society scenarios in a developing country: a case study in Malaysia  
Track Title: 3e  
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Preferred form of presentation: Oral

#### Abstract:

In order to mitigate climate change, Asian developing countries are increasingly important and will be more important in future because of its large population and ongoing and expected economic growth. Some of Asian developing countries face conflicts or dilemmas between policy targets such as: growth of industries and reducing energy demand, agriculture and forest conservation, food production and biofuel production. On the other hand, they may have synergetic effect by developing low-carbon societies such as; mitigation of outdoor air pollution in large cities and indoor air pollution especially in rural household, improvement of energy security, resource conservation by 3R, culming traffic congestion by using more public transport, and increasing employment in green industries.

The governments of those countries need to develop optimal strategies for respective countries considering complex relationship and balances of the factors above. In this study we have developed a methodology for designing low-carbon societies especially in those developing countries by using a couple of tools (simulation models): Extended Snapshot Tool (ExSS) and Agriculture/Forestry/Landuse model (AFOLU model). Extended Snapshot Tool (ExSS) was developed by the authors in previous studies. It is a static model consists of simultaneous equations and, given a set of future assumptions of development and energy technologies, projects consistent socio-economic variables, energy demand and supply in a particular future year. ExSS quantifies economic growth and changes in industrial structure, demography, changes of lifestyles in terms of consumption pattern and energy service demand, transport volume and structure, and low-carbon measures including energy-efficient devices and building, renewable energy, modal shift to public transport, fuel-mix in power supply and so on. Since it is highly flexible model, one can introduce a wide range of assumptions which are independent from each other and relatively free from current structure. This feature enables "designing" future society based on the idea of "back casting".

AFOLU model (Hasegawa *et al. in committee*) is a dynamic optimization model which describes activities of agriculture, forestry, other land use and land use conversion, and applied technologies related to greenhouse gases (GHGs) emissions in those activities. While ExSS is a static model, AFOLU model is a dynamic model because emission from land use conversion depends on its time-series path. AFOLU model quantifies impact of agriculture production (including both food and biofuel), changes in share of crops and livestock, forestry including deforestation, tree planting and conservation of existing forest, various measures which mitigate GHG (especially methane and nitrogen dioxide) emissions from agriculture.

We combined the two models by soft-link in order to simultaneously consider the three fields, socio-

economic development, energy, and AFOLU sectors.

A case study was conducted in Malaysia, one of the leading developing countries in south-east Asia. Energy consumption in Malaysia is rapidly growing while the country has a large reserve of natural forest and is the largest producer of palm oil, which can be a source of bio-fuel. We hence considered Malaysia was suitable for case-study of the methodology. Framework of the scenarios is as follows. Base year is 2005, target year is 2020 and 2030. The year 2020 was chosen because Malaysian government officially announced they will reduce GHG emission intensity by 40% in 2020 compared to 2005. Though, some of the low-carbon measures need longer periods than ten years, we chose another target year, 2030. Target GHGs are CO<sub>2</sub> emission from energy use, methane and nitrogen dioxide emission from agriculture, and CO<sub>2</sub> emission and sink by forestry. Socio-economic assumption was taken from existing literatures and the government's official target. Low-carbon measures were collected from Malaysia Second National Communication of UNFCCC and international literature.

The result shows that based on the socio-economic assumptions, final energy demand increased by 125% and 205% in 2020 and 2030 without low-carbon measures (hereafter called "BaU scenarios"). GHG emissions were 377MtCO<sub>2</sub>eq (2020) and 533MtCO<sub>2</sub>eq (2030). By introducing low-carbon measures (hereafter called "CM scenarios"), it can be reduced by 25% (2020) and 42% (2030) from BaU emissions. In terms of net emissions considering carbon sink by the forest, the emissions were 149 MtCO<sub>2</sub>eq (2020) and 316 MtCO<sub>2</sub>eq (2030) in BaU, and reduced to 31MtCO<sub>2</sub>eq and 69 MtCO<sub>2</sub>eq in 2020 and 2030. Among the low-carbon measures, the largest emission reduction in 2020 was by energy efficiency improvement in energy demand sectors (about 32% of emission reductions) followed by tree planting (23%). Though, in 2030, energy efficiency improvement in energy demand sectors had greater share (48%) and tree planting reduced its relative contribution (10%) since the area for tree planting is limited. Contribution of biofuel, mainly made from residue from palm oil plant, was 5.6% in 2020 and 6.3% in 2030.

Per capita GHG emissions without considering carbon sink were 6.7tCO<sub>2</sub>eq in 2005, 11.5tCO<sub>2</sub>eq (2020) and 14.3tCO<sub>2</sub>eq (2030) in BaU scenarios, 8.7tCO<sub>2</sub>eq (2020) and 8.3tCO<sub>2</sub>eq (2030) in CM scenarios. Net per capita GHG emissions were -9.3tCO<sub>2</sub>eq in 2005, 4.6tCO<sub>2</sub>eq (2020) and 8.5tCO<sub>2</sub>eq (2030) in BaU scenarios, 0.9tCO<sub>2</sub>eq (2020) and 1.9tCO<sub>2</sub>eq (2030) in CM scenarios.

The result indicates investment to energy efficiency improvement will be the most important for mitigating GHG emissions. In addition, the large carbon sink even in BaU scenarios suggest that if the country lose its forest reserve in a larger scale, it will cause significant increase of net GHG emissions. Since the biofuel introduced in the CM scenarios is mainly from agricultural residue and contribution of bio-diesel is less than 2% of total emissions reduction, it is suggested that biodiesel production could not be prioritized. In on-going research, the authors are developing tools for analyzing waste management and air pollution in relation with GHG emissions, and more integrated analysis will be possible by combining the tools.

Finally, the result above is based on our assumptions. Since main objective of this study is developing a methodology and providing tools for the governments, we do not claim this is the only one or "best" scenario for Malaysia. Different scenarios will be produced by different assumptions and hence will serve intelligence for strategic decision-making of the governments.

Paper Title: The Sustainable Procurement Initiative (SPI): Leveraging the Market Power of Combined U.S. Public Sector Purchases to Significantly Influence the Overall Market for Sustainability

Track Title: 4b

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#### C. Public participation: civic action for sustainable development and state engagement

##### **Abstract:**

This paper describes the strategy being used by the Sustainable Procurement Initiative (SPI) in the United States to leverage the combined market power of governmental procurements for sustainable products, services, and construction.

Sustainable policies aim to encourage the integration of environmental, economic and social criteria into the fabric of growth and development goals and objectives. Procurement that considers sustainability in contract award decisions for goods, services, and construction/works can be used to serve overall sustainability goals. While the benefits of sustainable procurement have been illustrated through the successes of Canada, Europe, Australia, and New Zealand, the sustainable public procurements made to-date in the United States appear to have been limited in scope and number and have not been organized to fully leverage the market power of combined U.S. federal, state, and local purchases.

Some of the policies in the United States are simply statements of intent, while others are formal programs that generally improve the environmental, social, and economic consequences of governmental operation and service delivery, which may or may not involve procurement initiatives. Although efforts have been underway for many years to encourage sustainable procurement in the U.S. public sector, there remains a huge, untapped potential to use the immense combined purchasing power of at all government levels to significantly advance and accelerate market development toward greater sustainability of goods, services, and construction in the market place. The SPI will tap this potential by engaging the private sector business community through a set of market-based incentives and business relationships.

Private sector vendors have one overarching goal: profitability. So, the question becomes one of how to leverage vendors and build more sustainability evaluation processes. In order to establish a mutually beneficial relationship between the vendors and the public sector purchasing professionals, expectations from both sides need to be communicated. Specifically, the concept of sustainable production and consumption needs to be explained to vendors in a way that communicates how the process can be beneficial to them as a business. For this purpose, four incentives for sustainability will be used.

The first of these incentives is the establishment of an organized market: an organized, identifiable, quantifiable, and continually growing market for sustainable goods, services, and construction organized through the use of large-scale cooperative procurements.

Second, the use of generally accepted metrics to establish relative sustainability will be used as an incentive. When a dimension of sustainability is measurable (e.g., noise level, pollution content or emission rate, percent recycled content), the solicitation document can contain both a minimum required level and an award incentive that gives credit to a bidder or proposer for the amount it's



offering exceeds the minimum. Current sustainable procurements in the United States focus primarily on establishing minimum standards only, thus negating the possibility of market competition driving the market toward continuous improvement of goods, services, and construction, beyond the minimum required.

Third, on issues where generally accepted metrics are not available, expert judgment will be used to establish relative sustainability. For example, in areas involving minimum damage to wildlife during construction, generally accepted metrics have yet to be developed. However, there may be some elements of these issues that are measurable. When measurable metrics cannot be feasibly used, regardless of the reason, the award incentive can be based on scoring by a panel of experts, strictly adhering to the methodology clearly explained in advance in the solicitation document. This type of incentive allows for a significant expansion of coverage over multiple dimensions of sustainability.

Finally, a review of vendor's plans for continuous improvement of sustainability will serve as an incentive for vendors to continue to improve sustainable aspects of their goods, services and construction. A statement of long-term sustainability objectives for goods, services, or construction should be provided in each solicitation document issued. This statement will give manufacturers, supply chain members, vendors, and contractors a road map they can use to plan the continuous improvement of the sustainability of their offerings, and thereby improve their competitive position over time, while also moving the market for sustainable goods, services, and construction forward.

Establishing a mutually beneficial relationship between procurement professionals and vendors can greatly facilitate the success of sustainable procurements in stimulating sustainable product growth and development.

Status to date:

Two pilot committees have been established at public universities in the United States; Mississippi State University and Old Dominion University. These committees are developing sustainable procurement plans for the purpose of purchasing goods, services, and contraction projects. The next step is to engage the vendor community in this process going forward.

Paper Title: City shrinkage in Japan: phenomena, managing and reviving policy strategies  
Track Title: 5a Sustainable Cities  
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## Abstract

### Background

Cities in developed countries throughout the world are facing population declines at an unprecedented scale. Over the last fifty years, 370 cities throughout the world with populations over 100,000 have shrunk at least 10% [1]. Wide swaths of the U.S., Canada, Europe, and Japan are projecting double-digit decline in population in the coming decades [2].

According to the census data in Japan from 2000 to 2005, over 93% of 2217 municipalities are losing their population. According to the population projection of NIPSSR, Japan will continue to decline at a rate of approximately 800,000 of population per year between 2010 and 2050 [3].

Depopulation due to out-migration and/or lower fertility and residential preferences change leads to a shift of inhabitants from city core to the suburbs, which will give rise to city sprawling in the city fringe as well as lower density of population near city core area [4]. Both population loss in the city core and sprawling peripheries will cause a dispersed city structure, which in the sense of environment, large brownfields and land wastage will be left in the city core, but new expansion in the suburb will destroy natural environment and ecosystem, on the other hand, from the perspective of inhabitants, due to the over low residential density, negative influence on quality of life may be generated by difficulties to

access to infrastructures, lose the sense of community and social segregation.

**Objectives**

Mechanism of phenomena highlighted should be well analyzed in the background. In order to take response to current shrinking trend, try to design and examine potential urban planning policies to manage, and if possible revive shrinking cities.

**Methodologies**

Based on comparative cases studies (present case study area is Katsuura-shi, a city located in the Chiba Prefecture, Japan), using land use map, census data, questionnaire survey etc. detects changes in land use, democracy and residential preferences. On the basis of the statistical analysis results of case study area in Japan, and the policies analysis of shrinking cities in Europe and North America, possible policy proposals will be considered to manage shrinking cities in Japan.

An innovative simulation model combined land use change model generated by Rent-gap theory based Cellular Automata [5,6] with residential migration model based on multinomial logit model [7] is built to project current trend of shrinking issues of case study area Japan, test the possible managing policy proposals and compare various policy scenarios.

**Results and Discussion**

According to the statistical analysis, Katsuura-shi is a typical shrinking area. A dispersed city with over low population density and large land wastage is a sustainable way of development. Aimed at maintaining the life quality of residents as well as preserving the environment, try to concentrate population in a proper sized city area in order to achieve a higher density and prevent from city sprawling by Limit new expansion on the arable land or undeveloped land, at the same time redevelop the existing city area by improving infrastructure and serves to attract residents move back to the inner city area.

The current trend of the migration choice and land use conversion has been projected by the simulation model, and the policy scenario has been tested in the simulation model. In trend projection by the simulation model, the residential area will still expand and occupy the arable land and forest in the suburb of the city, and residential migration result shows that among the households that have decided to move, 62% households will choose to move to the suburb while 38% of the households will choose to move to city center.

But if the accessibility to infrastructures and service has improved in near city core area, the utility to choose near city core can be higher. If the local government can limit the new land expansion, and cut budget to help the residential redevelopment, the redevelopment near city core area can be achieved in the cellular automata land use change model, and then the utility for choosing near city core area will be improved in the migration model. Hence, the policy proposal to limit the new expansion and redevelop residential area near city core can be a possible policy for managing the shrinking city.

In addition, the comparison of the effectiveness of improving various infrastructures or services during the residential redevelopment is discussed in the research (table1). a most practical and effective policy strategy to manage the shrinking issue in Katsuura-shi is that on the basis of the Katsuura local government's original plan to develop the public sewage system (the project has been processing since 2007), develop old center for aged residents and improving nursery and primary school for young children in the inner city, at the same time preserve space for park and green land in the city core area, which will be an effective way to increase the attractiveness of inner city as well as improve the life quality of residents.

Table1: change of percentage choosing to move to city core with the iterations of residential redevelopment

	0	10	50	100	200
Sewage	38%	39.9%	43.1%	45.2%	51.3%
Nursery	38%	40.9%	45.5%	47.8%	48.8%
Old center	38%	46.2%	50.6%	54.4%	56.1%
Park	38%	39.8%	41.3%	45.1%	45.2%
Primary school	38%	41.1%	46.3%	51.6%	54.7%
Hospital	38%	40.3%	41.0%	42.1%	42.5%
Disaster prevention	38%	38.3%	38.7%	40.1%	41.2%
Bank or Post	38%	38%	38%	38%	38%
Common meeting place	38%	38%	38%	38%	38%

Data source: results from experiment in simulation

**Reference:**

- [1] Oswalt, P and T. Rieniets. 2007. Global context. ShrinkingCities.<[http://www.shrinkingcities.com/globaler\\_kontext.0.html?&L=1](http://www.shrinkingcities.com/globaler_kontext.0.html?&L=1)> . Accessed Oct. 10 2011
- [2] Justin B. Hollander , Karina Pallagst and Terry Schwarz. Planning Shrinking Cities, 2009
- [3] NIPSSR (National Institute of Population and Social Security Research). Population Projections for Japan: 1996–2100, *Research Series No. 291*, 1997
- [4] Sigrun Kabisch, Annegret Haase and Dagmar Haase. Beyond growth-urban development in shrinking cities as a challenge for modeling approaches, 2006
- [5] Shun Wai Tsang and Yee Leung. A Theory-Based Cellular Automata for the Simulation of Land-Use Change. *Geographic analysis*, 43:142-171, 2011
- [6] Neil Smith. Gentrification and the Rent Gap. *Annals of the Association of America Geographers*, 77:462-465, 1987
- [7] Greene, W. H. *Econometric Analysis. 6th ed.* Upper Saddle River, NJ: Prentice–Hall, 2008

Paper Title: GHG Emissions and Mitigation potentials in Agriculture, Forestry and Other Land Use sectors in Indonesia  
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## Background

Agriculture, Forestry and Other Land Use (AFOLU) sector is one of the largest sources of the anthropogenic GHG emission, contributing 31% (Agriculture for 14.3% and Land Use, Land Use Change and Forestry (LULUCF) for 17%) of the emissions in 2004 (IPCC, 2007). To achieve the target cutting global greenhouse gas (GHG) emissions in half by 2050, it is important to evaluate quantitatively and specify types and amounts of countermeasures with high mitigation potentials and countries/regions which we should put priority on. Since especially in developing countries where primary industry shares a large part of domestic economy, a large part of domestic emissions comes from AFOLU sectors, quantitative evaluation of mitigation potentials in the AFOLU sectors is important to work toward the global goal. We have developed a model to estimate GHG emissions and mitigations in AFOLU sectors, named AFOLU Emission model (Hasegawa et al., in committee).

The AFOLU Emission Model is a bottom-up type model to calculate GHG emissions and mitigation potentials at the national/regional level, based on detail information of specific mitigation countermeasures. The emissions and mitigations are calculated under several marginal abatement costs for mitigations and are based on future scenarios of production in agriculture and livestock industry and land use change given exogenously. However, in application in the AFOLU Emission model to LULUCF sector, the model could not take into account (i) mitigation and costs in the whole application term, (ii) change in amounts of sequestrations over time due to forest growth and (iii) GHG emissions and mitigations in fires, disturbances and peat lands. In this study, we developed a model for LULUCF sector (LULUCF Model) as a part of AFOLU Emission Model. We applied the AFOLU Emission Model to Indonesia as one of countries where AFOLU sector accounts for a large part of the domestic emission and estimates GHG emissions and mitigations in LULUCF sector.

## Methodology

AFOLU Emission model consists of two models; Agriculture and Livestock Industry Model and LULUCF model. The Agriculture and Livestock Industry Model describes activities of producers of agriculture and livestock industry, types of crops and livestock animals to produce amounts and ways of the production and combinations of mitigation technologies, in order to maximize annual profit of the producers. LULUCF model describes combinations of mitigation technologies and calculates GHG emissions and mitigations in LULUCF sector. There are three characteristics in the LULUCF model.

Firstly, several types of constraints on amounts of mitigations and costs can be assumed as mitigation cases to compare and discuss several types of mitigation strategies in planning application and implementation of countermeasures. In LULUCF sector, compared to agriculture and livestock industry sectors, there are countermeasures to take long time such as plantations and forest managements. When starting the countermeasures, profits and mitigations not only in the year to start but also in the whole application period should be taken into account. To do so, in LULUCF model, we assume several mitigation strategies based on the assumptions; i) maximization of total profit in the whole application period and ii) maximization of profit in each year, under emission constraints or iii) maximization of total mitigation in the whole application period and ii) maximization of mitigation in each year, under cost constraints.

Secondly, amounts of emissions or mitigation are allowed to change over time after some countermeasures are applied. For example, amounts of sequestration of forest may change through forest growth after plantations. They may cause a time lag between when to apply the countermeasures and when sequestration is happened.

Thirdly, the LULUCF model calculates GHG emissions from fires, disturbances and peat lands. Ratios of area of fire or disturbance to total area of target land-use category (i.e. forest land) are given as a future scenario.

## Application of AFOLU Emission Model to Indonesia

## Assumptions and Settings

As an input to the AFOLU Emission model, we prepared future scenarios of crop production,

harvested area and yields of crops, number of livestock animals and area of land use and land use change. To consider the country specific situation, we referred basically national statistics and publications such as the Indonesia Second National Communication to the UNFCCC (NC2) and an international statistics such as FAOSTAT(2011) for historical trends and future plans. If governmental plans or prospective are not available, future scenarios are estimated based on the historical trend. We extrapolated trends of some activities up to 2030 using growth ratios calculated from the historical trends. We estimated GHG mitigation potentials under a wide range of Allowable Additional Costs (AAC), 0, 10, 100 and over 100US\$/tCO<sub>2</sub>eq for GHG emission mitigation in 2030.

GHG emissions and mitigation in AFOLU sectors in Indonesia

In 2000, total GHG emission in AFOLU sector is expected to be 580MtCO<sub>2</sub>eq. GHG emission from agriculture sector would be 73MtCO<sub>2</sub>eq and GHG emission/sink from LULUCF sector would be 734 and -230MtCO<sub>2</sub>eq, respectively. In 2030, in BaU case, total GHG emission in AFOLU is expected to be 740MtCO<sub>2</sub>eq. GHG emission from agriculture sector would increase 2.1 times. Especially N<sub>2</sub>O emission from managed soils and livestock are expected to increase drastically. Net emission from LULUCF sector would increase 1.2 times.

In the case of under 10US\$/tCO<sub>2</sub>eq of ACC, midseason drainage and off-season rice straw amendment in rice paddy are expected to reduce 18MtCO<sub>2</sub>eq, corresponding approximately 24% of emission in 2000. They are expected to greatly contribute to reduce a large amount of GHG emissions in agriculture in Indonesia. In LULUCF sector, countermeasures such as forest management, reforestation and reducing deforestation are expected to reduce 1.0GtCO<sub>2</sub>eq together, in 2030 under 10US\$/tCO<sub>2</sub>eq of ACC, corresponding approximately 180% of emission in 2000.

Paper Title: Mitigation potential in Agriculture, Forestry and Other Land Use sectors towards sustainable agricultural growth in Vietnam  
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To contribute the target cutting global GHG emissions in half by 2050, developing countries like Vietnam should actively develop and implement National Appropriate Mitigation Actions (NAMAs) on a voluntary basis to ensure sustainable development. Moreover, as a country providing a fifth of world food exports and also a country among the few worst affected by climate change, Vietnam should address this challenge so as to contribute more to global food security. GHG emission and mitigation potential from energy sectors in Vietnam in 2030 has been done by Hoa et al., (2010). However, Agriculture, Forestry and Other Land Use (AFOLU) sectors in Vietnam have been one of the largest sources of the anthropogenic GHG emission, contributing nearly 70% (Agriculture for 51% and Forestry and Land Use, Land-use Change and Forestry (LULUCF) for 19%) and 53% (Agriculture for 43% and LULUCF for 10%) of the emission in 1994 (INC, 2003) and 2000 (NC2, 2010), respectively. Therefore, reduction of emission resulted from agriculture activities has been considered it as a solution for a sustainable agricultural growth in Viet Nam. In this study, we developed a model named "AFOLU Emission Model" to estimate mitigation potentials as a result of profit maximization choice of technologies and assessed GHG mitigation technologies in AFOLU sector in Vietnam. AFOLU model is a multi-regional multi-sector bottom-up type model to estimate GHG emissions and mitigation potentials in AFOLU sector dealing with detailed mitigation technologies. We assume that producers (i.e. farmers) decide types of cultivated crops and livestock animals, amounts and ways of agricultural

and woody production and combinations of mitigation technologies in order to maximize their annual profit. We do not consider that producers change their land use. Based on the concept, AFOLU model solves the profit maximization problem under several constraints for pre-determined demand of agricultural and woody products. This model may help analyze effect of policies such as emission/energy tax, subsidy, and regulation and so on. We calculated GHGs emission ( $\text{CO}_2$ ,  $\text{CH}_4$  and  $\text{N}_2\text{O}$ ) from activities such as crop production, livestock animals and land-use change. GHGs emission sources are from livestock enteric fermentation, livestock manure, managed soils, paddy rice and land use change. The study estimated two scenarios in 2030 in Vietnam: (1) Scenario without low-carbon countermeasures (hereinafter referred to as 2030BaU); (2) Scenario with introduction of low-carbon countermeasures (hereinafter referred to as 2030CM), which is adopted low-carbon countermeasures to reduce GHGs emission in 2030. Projection of Vietnam's AFOLU sector development in 2030 is based on several sources such as NC2, GSO (2009), FAOSTAT (2011) and IRRI (2011).

The finding shows that total GHG emission in 2030BaU is expected to be  $61\text{MtCO}_2\text{eq}$ . GHG emission from agriculture sector would be  $81\text{MtCO}_2\text{eq}$  and GHG emission/sink from LULUCF sector would be 43 and  $-63\text{MtCO}_2\text{eq}$ , respectively. GHG emission sources of agriculture sector comprises managed soil ( $\text{N}_2\text{O}$ ), rice paddy ( $\text{CH}_4$ ), livestock manure ( $\text{N}_2\text{O}$ ), livestock manure ( $\text{CH}_4$ ) and enteric fermentation ( $\text{CH}_4$ ). The largest share 34% of total GHG emission of agriculture sector comes from rice paddy, following by managed soil (31%), enteric fermentation (22%) and livestock manure (13%).

We estimated GHG mitigation potentials by countermeasures under wide range of Allowable Additional Costs (AAC) for GHG emission mitigation in 2030. Mitigation potentials in AFOLU in 2030 would be 19, 35, 60 and  $68\text{MtCO}_2\text{eq}$  in the case of under 0, 10, 100 and over  $100\text{US}\$/\text{tCO}_2\text{eq}$  of AAC, respectively. In the case of under  $10\text{US}\$/\text{tCO}_2\text{eq}$  of ACC, midseason drainage (teq402) and off-season rice straw amendment are expected to reduce  $16\text{MtCO}_2\text{eq}$ , corresponding approximately 60% of mitigation potential of agriculture sector. GHG mitigation from rice paddy is expected to greatly contribute to reduce large amount of GHG emission in agriculture sector in Vietnam. In livestock sector, replacement of roughage with concentrates; dome digester, cooking fuel and light have high economic effects. These countermeasures in the case of under  $10\text{US}\$/\text{tCO}_2\text{eq}$  of ACC can reduce altogether  $6.0\text{MtCO}_2\text{eq}$  which account for halving 10 % for each of mitigation potential in the agriculture sector in 2030. Amount of GHG reduction from these two countermeasures remains the same in the case of under  $100\text{US}\$/\text{tCO}_2\text{eq}$  of ACC. In managed soils, split fertilization/optimized timing of fertilizers and sub-optimal fertilizer application are chosen to reduce 1 and  $4\text{MtCO}_2\text{eq}$  at under  $10\text{US}\$/\text{tCO}_2\text{eq}$  of ACC, respectively. In the case of cost at most  $0\text{US}\$/\text{tCO}_2\text{eq}$  of ACC, no regret technology, total mitigation potential of agriculture sector would be  $19\text{MtCO}_2\text{eq}$ . At over  $100\text{US}\$/\text{tCO}_2\text{eq}$  of ACC, expensive countermeasures such as daily spread of manure (teq204), slow-release fertilizer and organic soils/restoration are expected to additionally reduce emissions. In LULUCF sector, forest management, conservation of existing protection forest and government action plans (plantation, protection and conservation of forest) are expected to reduce 1, 2 and  $5\text{MtCO}_2\text{eq}$ , respectively, in 2030 under  $10\text{US}\$/\text{tCO}_2\text{eq}$  of ACC. However, at over  $100\text{US}\$/\text{tCO}_2\text{eq}$  of ACC, total mitigation potential is  $24\text{MtCO}_2\text{eq}$  which forest management and a combination of conservation of existing protection forest and government action plans account for  $19\text{MtCO}_2\text{eq}$  (79%) and  $5\text{MtCO}_2\text{eq}$  (21%), respectively.

The mitigation potential in AFOLU in the case of under  $10\text{US}\$/\text{tCO}_2\text{eq}$  of ACC is expected to be  $35\text{MtCO}_2\text{eq}$  which is approximately 66% and 8% of GHG emission in energy sectors in 2000 ( $53\text{MtCO}_2\text{eq}$ ) (NC2) and 2030 ( $446\text{MtCO}_2\text{eq}$ ) (Hoa et al., 2010). Midseason drainage and off-season rice straw amendment from agriculture sector and forest management from LULUCF sector are expected to be great mitigation potentials in AFOLU sector in Vietnam in 2030. This study's result, we hope, can contribute to develop a roadmap of action plan for sustainable agriculture, food safety assurance and climate change response in Vietnam.

## References

- Hoa, N. T., Gomi, K., Matsuoka, Y., Fujino, J., Kainuma, M., Shrestha, R. M.: Sustainable Low-carbon development towards 2030 in Vietnam, available at <http://2050.nies.go.jp/LCS>, February 2010.
- Vietnam Initial National Communication under the United Nations framework convention on climate change (INC), 2003. Socialist republic of Vietnam. Ministry of natural resources and environment.
- Vietnam's second National Communication to the United Nations framework convention on climate change (NC2), 2010. Socialist republic of Vietnam. Ministry of natural resources and environment.
- General Statistical Office (GSO), 2009. Statistical yearbook. Statistical Publishing House. Hanoi, Vietnam
- FAO, 2011, FAOSTAT. Available at <<http://faostat.fao.org/default.aspx>>

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IRRI, 2011, IRRI World Rice Statistic, Table 30. Available at  
<[http://beta.irri.org/solutions/index.php?option=com\\_content&task=view&id=250](http://beta.irri.org/solutions/index.php?option=com_content&task=view&id=250)>

Paper Title: Principles and Practices of a Politics of Sustainability Indicator Systems  
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### Abstract

Within the indicators movement, a new wave is cresting. This move, among other things, signals an end to the days of indicators crafted in laboratories, shielded by locked databases and cryptic formulae, and a dawn of the days of carefully crafted attention to improving the usability of indicator systems based on political and social theory. Social critique of indicators, of course, is nothing new. What is new to this current wave is the normative position of cautious optimism being taken by social and democratic theorists seeking to stake out a policy space for indicators in which they can be shown to contribute to a sustainability transition.

Whereas sustainability indicator systems were originally designed to alert people in a timely fashion to approaching quantitative limits of our living systems, we are currently hitting the limits of indicator systems in promoting the changes necessary for a sustainability shift in society. Since its origins in the early 1990s, the indicators movement has successfully produced considerable “MRV” information – measurable, reportable and verifiable (Hak et al., 2012). However, the goal has always been more than this, to “stimulate a process to enhance the overall understanding of environmental and social problems, facilitate community capacity building, and help guide policy and development projects” (Reed et al., 2006, 407). They *can* do these things; but few would suggest they *have* done all of these things in any real context where they have been tried. We lack an adequate understanding of or approach to how to use indicators toward policy change, or how to agree on the desired ends of this change. What this points to is a need, coupled with a readiness within the field of indicators, to develop the politics of sustainability indicator systems. This paper suggests principles for just such a reflexive politics, and tests recent sustainability indicator system advances in North America against their social and political usability.

However unlikely the assumption of instrumental use of indicators in policy processes has ever been, it is even less likely in contexts of multilevel, multi-scaled, multidimensional governance. Such contexts dominate the sustainability policy space. Effective research engagement in the politics of sustainability indicators entails the search for a deeper understanding of the different roles that indicator systems may play as we insert them into different governance contexts within the information society, layered upon the complexities of claims and policies specific to sustainability. The abundance and complexity of information available in any given sustainability policy context implies that, as a core criterion of freedom of choice, indicator audiences always have options about whether to accept the information on offer. More than options, this situation entails an expectation that indicators audiences will make judgments based on whatever means they have to reconcile the multiple and often conflicting pieces of information that constitute their own understanding of the context. From the point of view of those offering the indicator system up as new information, this situation demands that rhetoric, rather than scientific or political authority per se, be employed in order to secure the usability of the system.

Bauler (2012, 39) defines indicator system usability as: “the inherent, mostly implicit, potential of indicators to be considered by policy actors during their decision activities” (Bauler, 2012, 39). Usability analysis is proposed as a deliberative process of determining this utility of indicators at a series of different policy boundaries, considering context-specific understandings of systems’



legitimacy, credibility and salience. In this way, usability analysis may expose the mechanisms and patterns underlying the way in which different actors behave in specific policy contexts, at the crucial “intermediary moment between indicator construction and indicator use.”

Tying this notion to democratic theory, the usability profile of an indicator system depends upon its proponents’ discursive accountability; their ability “to communicate in terms that make sense in the discourse being represented, even as he or she makes representations to other actors, institutions, or discourses” (Dryzek, 2010, 75). Key to this is public deliberation toward a working agreement in spite of ongoing, non-reducible differences in values and beliefs. Referred to by Dryzek (2010) as “epistemic meta-consensus” and by Dewey (1927) as the creation of a “problem-solving public,” the steps in this process include agreement on the credibility of disputed beliefs, their relevance to the norms that define the issue at hand, and defining a course of action that participants can live with. Sustainability indicator systems that do not meet the test of discursive accountability fail to have an impact on policy because they meet an impasse of the fundamental values and beliefs that questions of sustainability put at stake. Informal understanding of this social process has led to certain indicator systems taking steps to increase their usability so understood. Formalization of these processes will help to further this agenda, as the pursuit of meta-consensus still leaves open important questions such as what to do with lingering dissensus at various fronts, how to bound such a process to maintain a sense of efficiency, and what forms of meta-consensus are not acceptable.

The operationalization of such a politics of sustainability indicators will be demonstrated through an analysis of a number of prominent sustainability indicator systems in the North American context: Vital Signs, the Seattle Happiness Initiative, the Canadian Index of Wellbeing and the LEED-ND system. These systems share a common challenge of operating outside of formal government and demonstrate different rhetorical approaches to the move to establish discursive legitimacy and epistemic meta-consensus. While none of these systems have achieved a flawless usability profile to date, they do demonstrate different advances and downfalls that we can learn from. Explicit attention to the politics of sustainability indicator systems has the potential to improve the results of these and other systems in their further embedding within urban policy.

### References Cited

- Bauler, T. 2012. An analytical framework to discuss the usability of (environmental) indicators for policy. *Ecological Indicators* 17: 38-45.
- Dewey, J. 1927. *The Public and Its Problems*. New York: Henry Holt and Co.
- Dryzek, J. 2010. *Foundations and Frontiers of Deliberative Governance*. New York: Oxford University Press.
- Hak, T., B. Moldan, and A.L.Dahl. 2012. Editorial. *Ecological Indicators* 17: 1-3.
- Reed, M., E. D. G. Fraser, et al. 2006. An adaptive learning process for developing and applying sustainability indicators with local communities. *Ecological Economics* 59: 406-418.

Paper Title: Tensions between the local and the national in environmental decision making: a case study on agriculture in An Giang Province, Vietnam

Track Title: 5e Agriculture and Regional Development

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Preferred format: Oral

Abstract: 673 words, excluding references

This paper argues that in order to create a sustainable response in agriculture to climate change, national and local decision making processes need careful co-ordination. It draws on empirical data gathered in An Giang Province and two sets of predictions, one about trends in population growth for Vietnam, the other on the possible impact a rise in sea level would have in the Mekong Delta.

1. An Giang Province, located close to Vietnam’s border with Cambodia and away from the coast, is the country’s foremost producer of rice for national consumption and for export (GOSV, 2011). This has been achieved over the course of 35 years through three linked developments: the granting

of land use rights to farmers in the 1980s; availability, adaptation and adoption of high yielding varieties (HYV) of rice since the early 1970s; and the more recent building of dikes of different heights which delay, even prevent, the annual inundation of farmland when the water level in the Mekong River rises in the monsoon season (Howie, 2011).

2. Rice (*Oryza sativa* L.) is the staple food for about half the World's population, but it has a low intolerance of salt (Koyama *et al.*, 2001; Yeo *et al.*, 1985). Stretching inland from the coast, large areas of the delta will experience saline intrusion, should climate change proceed as predicted (Wassmann *et al.*, 2004), so rice production in provinces close to the coast is likely to decline. Work to refine the prediction model is on-going, but so far it suggests as much as 75% of the land area may be inundated, should the level of the sea rise 40cm in height by the year 2050. Nevertheless, provinces away from the coast, such as An Giang, will not be affected, or not to the same extent, as at the coast, should the level of the sea rise. Thus An Giang Province, located from the East Sea, can be expected to play an even larger role in creating food security in the future in maintaining Vietnam's food security.

3. The population of Vietnam is predicted to rise from 89 million in year 2009 to 108 million in year 2049 (GOSV, 2011). As poverty levels are reduced, consumption patterns can be expected to change. Both these factors will result in greater demand for food, particularly rice, and ecosystem services.

4. Some farmers in An Giang Province cultivate rice within walls of a height intended to prevent the entry of any flood waters. This system can produce three harvests per year, and some farmers harvest seven crops of rice in two years. However, research with farmers in an area of the province which has benefitted from high dikes for several years, indicates that yields decline once land is no longer subject to annual flooding: the amount of rice harvested per unit of fertiliser applied is declining. Some decision making has been delegated to farmers at commune level, such as development of infrastructure, which includes local dike building (GOV, 2003), but much remains with the government. High dikes may, in the short term at least, create more year-round employment for landless people (Howie, 2005). However, farmers in one area declined to support government plans for a high dike over a period of several years, on grounds that productivity would fall. In areas where high dikes already existed, some farmers are converting to other crops. Nevertheless, government plans to increase the number of high dikes exist. This raises the danger that more land will move out of rice production and no longer be available for growing rice. This may endanger food security.

There are tensions between the plans of the province, who wish to reduce poverty, the wishes of farmers, who are 'the local land managers' (Blaikie and Brookfield, 1987) and expressed concerns about a decline in productivity within high dikes, and the future food security of Vietnam. In these circumstances, whose will should prevail, local farmers, the government of the province, or the national need for food security in the future, and how should that be decided?

Blaikie, P. and Brookfield, H. (1987) *Land degradation and society*, London: Methuen.

General Office of Statistics, Vietnam. (GOSV) [available at [www.gso.gov.vn/default\\_en.aspx](http://www.gso.gov.vn/default_en.aspx) accessed 18/12/11]

Government of Vietnam (GOV) (2003) Decree 79/2003/ND-CP of July 7, 2003, *Promulgating the regulation on the exercise of democracy in communes*, Article 9 b.

Howie, C. (2011). *Cooperation and contestation: farmer-state relations in the agricultural transformation of An Giang Province, Vietnam*. London: Royal Holloway, University of London [available at [Co-operation and contestation : farmer-state relations in agricultural transformation, An Giang province, Vietnam](#). accessed 19/12/11]

Howie, C. (2005) High dykes in the Mekong Delta in Vietnam bring social gains and environmental pain. *Aquaculture News* 32 pages 16-17. [available at [http://www.aqua.stir.ac.uk/public/aquanews/downloads/issue\\_32/32P15\\_17.pdf](http://www.aqua.stir.ac.uk/public/aquanews/downloads/issue_32/32P15_17.pdf) accessed 19/12/11]

Koyama, M. L., Levesley, A., Koebner, R. M. D., Flowers, T. J. & Yeo, A. R. (2001) Quantitative Trait Loci for Component Physiological Traits Determining Salt Tolerance in Rice. *Plant Physiol.*, 125, 406-422.

Wassmann, R., Hien, N. X., Hoanh, C. T. & Tuong, T. P. (2004) Sea Level Rise Affecting the Vietnamese Mekong Delta: Water Elevation in the Flood Season and Implications for Rice Production. *Climatic Change*, 66, 89-107

Yeo, A. R., Caporn, S. J. M. & Flowers, T. J. (1985) The Effect of Salinity upon Photosynthesis in Rice (*Oryza sativa* L.): Gas Exchange by Individual Leaves in relation to their Salt Content. *Journal of Experimental Botany*, 36, 1240-1248.

Paper Title: Land Governance for Large-Scale Land Acquisition in Complex Contexts: the Case of Rwanda  
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### Introduction

The Government of Rwanda, a resource-poor country with the highest rural population density in Africa, has shown itself to be very willing to embrace large-scale foreign investment in agriculture and biofuels. Examples include sugarcane production and jatropha production. Given the land scarcity and extreme land fragmentation the country faces in the medium term (Huggins, 2009), it is imperative to evaluate the repercussions of such land acquisition, particularly in terms of food security, environmental sustainability, and poverty reduction. Initial reports suggest that the benefits of such investment might be outweighed by negative impacts on local community-members (Huggins, 2011a; Veldman and Lankhorst, 2011). However, the various social, political and economic impacts of such 'investments' can only be understood within a broader analysis of the political economy of land acquisition and agricultural production in Rwanda. It is important to consider the various dimensions of land tenure security as well as the broader reconfiguration of patterns of access to credit and inputs, systems of marketing, technologies of surveillance and socio-economic control which are leading to major changes in rural communities.

### Land and Agricultural Reforms, 2005-present

The Government of Rwanda, with considerable donor support, has over the past 6 years launched simultaneous reforms in the land and agricultural sectors. There is an assumption on the part of many actors – particularly bilateral donors, multilateral institutions such as the World Bank, and investors – that the land sector in Rwanda is very well-governed (Ali *et al*, 2011). The land registration programme has generally been seen as a success. However, evidence suggests that the Rwandan government considers a hierarchical 'command-and-control' approach and executive privilege to be more important than strict adherence to the 'rule of law' (Huggins, 2011b). For example, the government's constant use of 'land-sharing' to resolve land disputes has threatened to undermine the idea of land tenure security. This raises a risk that land rights may not be respected where they are deemed by the authorities to be an obstacle to 'development'. Moreover, despite Rwanda's reputation for 'zero-tolerance for corruption', there is a record of land grabbing by political and economic elites, from the pre-genocide past through to the current period.

Arguably of even more importance is the way in which land rights are severely undermined by contemporary controls on land use and agricultural production. Agricultural reform aims not only at increased production, but also consolidation of land use and marketing options, and a profound shift in farming practices towards export-oriented commercial models (Ansoms, 2009). Intercropping has been banned, as have many drought-resistant staple crops. Farmers are forced to purchase fertiliser on credit, and are arrested for selling it or applying it to non-commercial crops (Huggins, 2009). The paper will discuss some of the impacts of these policies on farming households. Government policies characterize smallholder farming as 'hopeless' and aim for a massive reduction in the population

engaged in agricultural production by 2020. Smallholder autonomy and indigenous knowledge have no place within the government's technocratic and 'high modernist' vision. Because of government controls, smallholders who recently registered their plots lament that they "work for the state". However fieldwork reveals that smallholders use micro-practices of trickery, diversification and negotiation to try to maintain some control over livelihoods.

### Methodology

The paper is based on fieldwork, 2003-2011, particularly PhD fieldwork conducted in 2011, in two Districts with different agro-ecological profiles. A focus on the composition and activities of agricultural cooperatives reveals the institutional framework of the agricultural reform while hundreds of interviews with smallholders document household-level impacts. The research broadly follows a materialist political economy perspective. Field data is contextualized through extensive review of secondary literature.

### Conclusion

The narrow technical focus and/or ahistorical framing of events employed by some actors misses the complex socio-economic and socio-political impacts of land and agricultural reforms, particularly in post-conflict or authoritarian states. In particular, the gap between policy elaboration and policy (re)interpretation and implementation is not taken into account (Pottier, 2003). In order to examine this gap, research must engage with the problems of collecting 'grassroots' experiences and perceptions in a context of authoritarian governance and self-censorship. This presentation and paper will provide a comprehensive overview of the question of 'land and agricultural governance' in Rwanda. This issue is of great importance not only because of the great socio-political and socio-economic challenges facing the population of Rwanda, but also because Rwandan state initiatives are often held up as positive examples of 'good governance in Africa', and many other countries purport to learn from these examples. For example, 'land-sharing' is being conducted in Burundi.

### Brief Bio

Chris Huggins has been conducting research on Rwanda since 2003. He was Rwanda Researcher for Human Rights Watch from 2005-2007. He has published extensively, and is co-editor (with Scott Leckie) of *Conflict and Housing, Land and Property Rights: A Handbook on Issues, Frameworks and Solutions* (Cambridge: Cambridge University Press, 2011) and (with Jenny Clover) *From the Ground Up: Land Rights, Conflict and Peace in Sub-Saharan Africa* (Nairobi: ACTS Press/ Pretoria: Institute for Security Studies, 2005).

### References

Ali, D., K. Deininger and M. Goldstein (2011) *Environmental and Gender Impacts of Land Tenure Regularization in Africa: Pilot evidence from Rwanda*. Washington DC: The World Bank. Policy Research Working Paper 5765

Paper Title: Land acquisition for hydropower dam construction: Changes in livelihood of forest-dependent people in Thua Thien Hue province, Vietnam  
Track Title: 5f Land Acquisitions  
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### Abstract

Thua Thien Hue province is one of provinces in Vietnam where a high potential for hydroelectricity has

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resulted in the construction of dams for energy sources and water supply, while simultaneously regulating water flows to adapt to erratic rainfall patterns under climate change regimes. Like everywhere, these developments are causing the involuntary displacement of (forest dependent) people, living in the mountainous areas where most of the hydroelectric dams are built.

This research examines the effects of hydropower establishment to the changes in entitlements to forest land for displaced forest-dependent people in Thua Thien Hue province, and to what extent their livelihoods have changed through resettlement. Special attention is paid to the aspect of livelihood vulnerability in the resettlement area, when access to forest resources decreases.

The research was conducted in Bo Hon and A Den villages in Thua Hue Province. The villagers are displaced caused by the establishment of dams for Binh Dien and A Luoi hydropower plants, respectively. Qualitative and quantitative analysis methods were employed to analyze data derived from a household survey, key informant interviews, participatory village mapping and village meeting

The research revealed that Ka Tu, Kinh and Ta Oi ethnics live in the original villages. They are all defined as forest-dependent people. All use the forest for income and subsistence needs. In addition, Ka Tu made use of the forest especially to collect non-timber production forest (bamboo) as a main source of income. Kinh depended almost completely on the forest through NTFP collection for sale. Ta Oi relied on production forest (fast growing species) to gain additional income but gained main income from sedentary agriculture (cassava and corn). In the resettlement area, these subsistence and income opportunities from the forest have completely vanished. Access to forest areas could no longer be secured. Instead, they had to change their livelihood into intensive agriculture. Although they received compensation payments, this was too little to cover the investment costs for more intensive agriculture and to buy food and construction materials, which could be obtained for free from the forest in their previous villages. These findings demonstrate the need to elevate participation level of displaced forest-dependent people on decision making resettlement program which is paid attention on carefully selecting the resettlement areas and on decision making in choosing the compensation types.

**Keywords:** Hydropower dam, involuntary displacement, forest-dependent people, livelihood, entitlement, Thua Thien Hue, Vietnam

Paper Title: A new approach to cool building spaces in tropics: Low Exergy cooling mechanisms

Track Title: 2c

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### **Abstract:**

Air Conditioning systems consume most energy of buildings in the tropics. The general practice is to cool a space using large amounts of air which has low density and heat capacity. We explore low exergy methods of cooling which reduce dependence on air as a temperature control medium, and strive to increase building performance. These systems help generate flexible & high performance building designs. A major obstacle though in the application of exergy concepts to buildings is the lack of an accepted definition of the reference environment.

If the latent demand is separated from the sensible demand then tremendous energy savings can be achieved. A system using this concept has been implemented for the heating case in Switzerland, and a similar system is being created in Singapore as a part of the research in Future Cities Laboratory (a collaboration between ETH, Zurich and Singapore) to manage the cooling case.

The latent demand and IAQ issues are handled by a decentralized ventilation system which dehumidifies the incoming air. The sensible demand is catered to by high temperature radiant cooling panels, which use large surface areas while also activating the thermal mass of the construction. Thus, the amount of air using low condensing temperature for humidity removal is minimized. The challenges faced by such a system, include risks of condensation & low air movements. We will try to analyse if cooling can be provided more effectively with less focus on conditioning of air, and more focus on the effective removal of heat.

Paper Title: Development of sustainability of land remediation contaminated by hydrocarbon  
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**a) Real world problem to be addressed and its significance for sustainable development:**

Sustainable remediation has been defined by SuRF (UK) as “the process of assessing sustainable remediation as ‘the practice of demonstrating, in terms of **environmental**, **economic** and **social** indicators, that the benefit of undertaking remediation is greater than its impact and that the optimum remediation solution is selected through the use of a balanced decision-making process”.

Land is one of the major problems created by the industrialization. Land is contaminated in several ways such as waste disposal, chemical contaminates, abandoned sites etc. Approaches to taking decisions on the management of contaminated sites has been changed markedly. However those approaches are not adequate to sustain the environment where environmental decisions must be ‘socially-robust’ within a context of sustainable development.

The UK Government’s sustainable development strategy “Securing the Future” aims: “.. to enable all people to satisfy their basic needs and enjoy a better quality of life without compromising the quality of life of future generations.” A study by Environment Agency shows that there are around 100,000 contaminated land sites which totals around 300,000 hectares. About 90% of the sites remediated in 2010 were contaminated with hydrocarbon (Environment Agency, 2010). There is no specific Regulatory Policy Framework to choose the most sustainable remediation strategy to treat a land contaminated with hydrocarbon.

Environment Agency determines circa 150 deployment forms (Land Remediation) each year. The Number of deployment application is increasing and there are circa 33,000 sites affected by in England and Wales waiting to be remediated. Selecting the most suitable remediation technology important but for sustainable development there needs to be certain regulatory policy framework for each technologies that industries must comply with. Defra and Environment Agency are keen the industries to practice sustainable remediation solution.

Health protection criteria, cost, effectiveness, technical practicability and regulatory acceptance is being used historically as selection criteria in remediation industry in United States. According to the SuRF White Paper the selection of remediation technologies should also evaluate the probability with which the current and future projects will have environmental and social benefit. (Section 2.1, SuRF White Paper). Although according to SuRF White Paper there is no specific regulatory or legislative requirements, the stakeholders have started using sustainable principles during the remediation technology selection process. SuRF-US White Paper discussed about different kinds of approaches and tools that are currently available to assess sustainable practice in remediation.

Integration of sustainable remediation hydrocarbon impacted land can be described as the blending of data, applications, and processes into a functioning, unified whole. “Regulations create many benefits for citizens and companies. They help to improve public health and safety, and they provide social and environmental benefits for citizens. They also provide legal certainty for consumers and companies in the process of buying and selling products and services.” (Ballantine and Devonald, 2006) Regulation

is an administrative legislation which is important in sustainable remediation of land contamination as this constitute or constrain rights and allocates responsibilities and without any regulatory boundary imposed in the remediation activities it may have impact on human health, habitat, local environment and in the economy. Integrating ESE dimensions with regulatory dimension will allow us not only to survive but also to succeed in a world of sustainability that is increasingly changing. Integrated regulatory policy will allow us to convert individual policies for individual dimensions into a resource that can be used by other individual dimensions. In addition, by integrating ESE dimensions with the regulatory dimension, the Environmental, Social, Economic and Regulatory (ESER) policy framework will become more robust than that of a series of isolated policy frameworks.

From the work of SuRF UK, SuRF US, SuRF Australia and the analysis of sustainable remediation tools, specially SRT and SiteWise, it can be inferred that while researches on the environmental, social and economic (ESE) dimensions of sustainable remediation of land contamination and sustainable tools have developed significantly to make the remediation of land contamination more sustainable, much more research needs to be done to integrate ESE dimension with regulatory dimension.

**b) Description of the method chosen to address the problem**

This research proposes identifying and assessing the current regulatory policies against the environment, social and economic criteria developed by SuRF-UK. The research proposes to identify regulatory bodies for the ESE (Environment, Social and Economic) dimensions. For example, the Environment Agency regulates Part1 and Part 2 operations of the Environmental Permitting Regulations. The Environment Agency also regulated water discharge, water quality, Natural England (NE) regulates the habitat, Local Authorities (LA) regulated social dimensions.

After identifying the regulatory bodies the research will progress with the identification of the gaps within environmental, social and environmental dimensions and linking each dimensions with the other two dimensions. Interviews are the path to develop and establish a completely new framework. I shall focus on three groups, e.g. regulators, developers and consultants.

social and the economic criteria. I shall conduct interviews with different types of stakeholders. E.g. regulators, developers, consultants and the environmental lawyers. Semi structured interview protocols will be used and it will include primarily open-ended questions. This way I shall have a better chance of learning about the perceptions and experiences of those being studied by using open-ended questions. At least two case studies (based on the hydrocarbon impacted land with in the UK) will be carried out to justify the research findings.

**c) A brief description of results/conclusion and their implications for future study /policy, or a summary of progress**

The vision of sustainable human society resides in the simultaneous and synergistic creation of conservation of natural resources and the natural environment, and sustainable social development and social justice, economic growth and equity and the legal boundaries. Therefore, in essence, it involves environmental, social, economic and regulatory (ESER) aspects to be taken into consideration equally. Only when all four balance, i.e. at the centre where the four circles overlap, can be truly sustainable (re)development.

This is an ongoing research work. The aim of this research work is to compare the regulatory frameworks currently being used and to develop an integrated regulatory policy framework for the sustainable remediation of lands contaminated by hydrocarbon.

Paper Title: Balancing Sustainability Challenges:  
A Case Study of Establishing Textile Production in the Developing World  
Track Title: 4f Global Product Chains  
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Sustainability is today, without question, a core issue for the development of new businesses (Jackson, 2009). Poverty, child labour, a changing climate, and exploitation of finite natural resources are just a few macro challenges which have gained extensive attention in the contemporary business society. We also know that the modern economy is structurally dependent on the development of new businesses. Everything from the survival of small villages to nations' economies and common welfare systems are underpinned by the same structures. While there has been extensive attention paid to the contemporary consequences and the macro challenges, limited attention has been paid to the hands-on real life challenges of establishing new and more sustainable businesses. The purpose of this study is therefore *to describe and analyse the practical challenges of incorporating social and environmental sustainability when developing a smaller manufacturing enterprise (SME) in the developing world.*

In order to reach this purpose an exploratory case study approach was chosen (cf. Atkinson and Hammersley, 1998). Case studies are acknowledged as useful in the identification of important variables in situations in which there is little control over (cf. Yin, 1994) and is strengthened by its possibility to combine data collection methods (Eisenhardt, 1989). The empirical material was collected between 2008 and 2011 from a variety of sources including interviews, meeting participation, and public documents.

The pursuit for economic growth and social equity, combined with a concern for carrying capacity of natural systems, allows sustainability to be a multifaceted concept. It incorporates micro, meso, and macro levels of both environmental, social, political, technological, as well as economical objectives (cf. Pezzoli, 1997a; 1997b). In order to go beyond the semantic surface meaning of the empirical material, and instead deepen the understanding of the practical challenges, the material was analysed and interpreted against a theoretical frame of reference (Braun and Clarke, 2006). The theoretical framework utilized, is based on four dimensions presented by Pezzoli (1997a). These dimensions are (1) the environment; (2) the legal institutional terrain; (3) culture and civil society; and (4) the economy and technology.

The case concerns two young Swedish entrepreneurs (Jonas and Anders) struggling to make a change when establishing a sustainable textile production in the rural areas of Bangladesh. The desire to embark on this journey came from a developing notion that something with the business-as-usual model of the throw-away society was wrong. When developing the idea the entrepreneurs were able to foresee some challenges, but others occurred more as unexpected problems. In this paper we focus on three main challenges with implications for how environmental and social sustainability would be achieved in the endeavour. These challenges relate to establishment, product customization, and value creation.

The first challenge occurred early on when deciding how to take control of the product chain. Having studied other organizations focusing on social and environmental business ideas the discussion of a code of conduct became pressing. Would they develop one based on the international labour organizations' standards and the fair trade organizations or would they build the production chains from scratch based on their own notions of social and environmental sustainability. They saw advantages and disadvantages with both options and ended up visiting Bangladesh in order to further investigating the issue.

The second challenge concerned the limitations of the most sustainable raw material and how to customize it for the Swedish market. Their research had shown that textiles based on cotton were no alternative due to unsustainable water use. Thus, they settled on jute and hemp to develop products

such as baskets and doormats. But how could these products (that they did not want to dye due to the environmental problems of that process) be manufactured to be attractive enough for consumers so that they would last through fickle decorating trends and in fact be long lasting valuable products in the homes of the consumers?

The third challenge revolved around finding sustainability interested retailers in Sweden who would promote the values in the products, but at the same time not oversell them. Thus, integrating the social and environmental fundamental values throughout the entire product chain.

The three challenges described above incorporates the increasing demands for more social and environmental sustainable business-to-consumer products, the identification and formation of markets, and the process of re-positioning products through the development of a new innovative business model. In that way it addresses the micro issues in the decisions, considerations, and problems presented when trying to start up a new business, implement an alternative business model, and influence the supporting structures of the existing industrial textile cluster. Drawing from the sphere of economy and technology described by Pezzoli (1997) the challenges of the case also bring forward questions related to how new products together with social learning and social change can bring production and consumption into concert with the capacity of the ecosystem to perform life-giving functions over the long run. Understanding how the challenges developed, were addressed and how they can be related to an overall sustainability framework is part of the ongoing research endeavor.

#### **Acknowledgements**

Jacobsson and Jansson undertook this study in close cooperation with redQ owners and founders Jonas Forsberg and Anders Sandlund. The case is based on actual events and the company redQ is in full operation and development.

Paper Title: Policy Translation of Industrial Symbiosis: A framework to connect national policy and local initiatives  
Track Title: 5c Regional Sustainability and IS  
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#### **Abstract**

With the emergence of Kalundborg model industrial symbiosis (IS), characterized by exchange of material, energy, and by-products, etc. within industries, draws much attention of governmental agencies, NGOs, firms and researchers, etc. The growing policy interests in applying industrial symbiosis concept lead to the development of eco-industrial initiatives, especially EIPs practices. So far, researches of IS mainly developed by natural scientists and engineers and focus on technologies, Material Flows Analysis, Life-Cycle Assessment, etc., while the policy and management perspective is not being explored properly, and policy lessons drawn from previous initiatives are confusing. The aim of this article is building a conceptual framework to explore the policy translation process with the central theme that connecting national policy and local initiatives. In the following part, a process perspective is adopted as industrial symbiosis requires the analysis of dynamic evolving processes of building exchanges and related institutional capacity.

In the last two decades, the ideas of industrial symbiosis have been adopted by many governments worldwide as policy programs, such as National Pilot EIP Program(NPEP) in China, EIPs in The



Netherlands and National Industrial Symbiosis Programme (NISP) in UK, and so on. In addition to the policy initiatives, many researchers argue that to some extent policy programs are one of the main driving forces for local industrial symbiosis initiatives. Although researchers already realized the crucial impacts of policy on local initiatives, systematic research about national industrial symbiosis policy and management system, as well as evolution of the policies is not explored largely, which are in the urgent need for forthcoming research. So **policy as industrial symbiosis** should be included in the framework to find out pathways of how principles of industrial symbiosis are incorporated into national policy and what the characteristics of the development of national policy and management strategies are.

Through tracing changing national policy and management strategies in the national level, we propose to further explore the mechanisms of the policy dissemination phenomena which connecting national policy and local initiatives. In policy science, four concepts are often used to explain the dissemination phenomena, which are policy implementation, policy diffusion, policy transfer, and policy translation.

Policy implementation emphasizes on executing the objectives of a policy into an operating program usually in the top-down hierarchy direction. Policy transfer and policy diffusion are both used to explain ways of how knowledge about policies used across time or space in the development of policies elsewhere, while the latter one emphasizes on the convergence of policy. Compared to the former three concepts, translation perspective emphasizes on disembedding policy ideas from their previous context and using them as models for a new context. It draws attention to the importance of a deepened problematisation of the policy concept, to actors' influences through their interpretations, attitudes and actions, as well as to the fact that translation processes are always tied to local contexts. So, we propose to take policy dissemination phenomena as a continuous translation process – actors, such as researchers, consultants, and NGOs, implementing organizations, etc., involve in disembedding concept from the origin contexts and re-embedding it to another different local contexts. What's more important, translation process is expected to go both ways: policy diffusion from the national to the local level, as well as learning from the local level to higher levels and back. So **policy translation** is the key concept in the framework for exploring the mechanisms of connection among national, regional and local level of IS initiatives.

On the influences of national policy and various translation process, regional and local level actors take actions to meet the policy objective, or (and) improve industrial competitiveness, or (and) improve environmental quality, etc. The process of local event to apply and stimulate IS development induced by national policy also need to be explored, which is the outcome of national policy on the one hand, and is the knowledge and information resources as feedback learned by national level actors on the other hand. So, in this perspective and with two directions of policy translation, we propose to take policy development and local practice development as co-evolution process. That is, policy is the conditioning factor for local initiatives, and local practice also is the conditioning factor for policy evolution. So, **co-evolution of policy and local initiatives** is another concept in this framework, and the mechanisms of co-evolution between them also need attentions.

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In conclusion, the article proposes a conceptual framework to connect national policy and local initiatives. It will include empirical data from a preliminary study in the Netherlands, which aims to uncover the diversity of mechanisms through which the national, regional and local levels are connected in the development of EIPs.

## References

- Atkinson, P. and Hammersley, M. (1998), "Ethnography and participant observation", in Denzin, N. K. and Lincoln, Y. S. (Eds.), *Strategies of Qualitative Inquiry*, 110-136.
- Braun, Virginia and Clarke, Victoria (2006), "Using thematic analysis in psychology", *Qualitative Research in Psychology*, Vol. 3, No. 2, pp. 77-101.
- Eisenhardt, K. M. (1989), Building theories from case study research. *Academy of Management Review*, Vol. 14, No. 4, pp. 532-550.
- Jackson, Tim (2009), "Prosperity without Growth? The transition to a sustainable economy", *Sustainable Development Commission*.
- Pezzoli, Keith. (1997a), "Sustainable Development: A Transdisciplinary Overview of the Literature", *Journal of Environmental Planning and Management*, Vol. 40, No. 5, pp. 549-574.
- Pezzoli, Keith. (1997b), "Sustainable Development Literature: A Transdisciplinary Bibliography", *Journal of Environmental Planning and Management*, Vol. 40, No. 5, pp. 575-602.
- Yin, K. R. (1994), *Case Study Research: Design and Methods*, 2<sup>nd</sup> ed., Beverly Hills, CA: Sage Publishing.

Paper Title: EcoBlok – a label to transfer standard environmental information along the product chain

Track Title: 2a

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## Abstract

Many studies have highlighted that unsustainable consumption patterns, especially in industrialized countries, are the main cause of environmental degradation. When assessing the environmental burdens of a product, it is important to note that individual businesses no longer compete as isolated entities, but rather as supply-demand chains in a complex network of multiple business relationships. The most significant environmental impacts associated with a product often happen in parts of the supply chain other than the premises of the company that manufactures the product. It is impossible to adequately assess the environmental performance of a product without looking at the whole life cycle of the product; conversely, the performance of a company can hardly be assessed without looking at its supply chain and at the future implications of the products it sells. We need to think in cause-effect chains, with a better view of how our actions affect the whole system.

Life cycle assessment (LCA), as defined by the ISO 14040 series, is a well recognized approach by both academia and business, with abundant report in the literature of its use for eco-design and eco-labelling. However, it has not contributed much to "life cycle thinking" in businesses, perhaps because it is often time consuming, data intensive and requiring expert advice, and hence it is expensive and

difficult to reconcile with product development and marketing timetables. Overall, these issues do not allow an easy comparison of LCA among different sectors, products and studies.

This paper discusses the application of life cycle thinking to everyday business, resulting in the development of the EcoBlok label. Our research goal was to develop environmental performance indicators that could be standardized across products and organizations. The vision of EcoBlok is that any product (goods or service) will have a standard quantitative environmental label, computed with a life cycle approach. The EcoBlok label can be used to carry life cycle information between organizations and across the production chain; and also to inform a buyer on the environmental performance of a product.

The EcoBlok method was designed according to the following basic principles:

Environmental information shown in product labels should be representative, comprehensible, and reflect product life cycle;

Environmental information should be based upon quantitative indicators, expressed in common physical units, because measurement is essential for performance evaluation;

Information should be synthesized in a small number of mutually independent indicators, to maximize information while facilitating comprehension;

Products, organizations and communities are components of a global coherent system: the environmental information, as defined by the method, should be portable across products (goods, services), organizations (companies, institutions) and communities (towns, cities, countries).

To comply with these principles, six “key indicators” were devised: (i) water abstraction, (ii) resource extraction, (iii) land use, (iv) greenhouse gas emissions, (v) other polluting emissions to air, and (vi) polluting emissions to water and land. The key indicators describe a broad range of environmental pressures, including natural resources use and pollution. Each key indicator is computed from one or more variables, weighted by equivalence factors that convey the environmental significance of each variable, using (as much as possible) objective criteria to avoid subjective judgements. The “environmental pressure” approach was adopted because it is the easiest to measure and standardize, while still providing environmentally significant information. Common management indicators such as energy consumption or waste production were not selected as key indicators because (i) they are highly correlated with one or other indicators, hence would be redundant, and (ii) they can easily be translated into the selected set of key indicators.

For some purposes, the six key indicators may be aggregated into the EcoBlok Index, inspired on the ecological footprint concept.

The method ensures consistency across different kinds of products, organizations and geographic boundaries, which are seen as components of a global system. Special attention has been paid to the availability and compatibility of data, which should be obtained from common environmental management systems, environmental or sustainability reporting, or official statistics.

The method has been tested in a number of applications, including eco-labelling, eco-design, benchmarking and supplier selection. Testing to date suggests that the EcoBlok approach seems an interesting option to apply life cycle thinking to real business situations where more conventional LCA would not in practice be used.

On-going work is focused on the computation of the ecological footprint of Portuguese consumers by group of consumer products. Early results suggest that the EcoBlok method will allow us to: (i) analyze how changes in consumption patterns affect the pressure on our environment; (ii) have an idea of how sustainable (or unsustainable) we are, because the product labels can be readily compared with available resources.

EcoBlok may be used in a larger scope of applications, depending on one hand upon further refining and testing, and on the other hand on automation and linkage with LCA databases. Further applications under study include environmental reporting and environmental taxation.





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**HOW READY IS THE NIGERIAN SOCIAL STUDIES EDUCATION PROGRAMME  
FOR THE MAINSTREAMING OF EDUCATION FOR SUSTAINABILITY  
CONCEPTS?**

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**Abstract**

This paper bears in mind the problems associated with climate change, such as loss of biodiversity, deforestation and desertification, and pollution of various sorts and their irreversible problems and disaster which humanity might encounter: if mitigations and preventive efforts are not made to sensitise people of their imminent dangers, and by that make people to develop the right type of attitude to the environment, society and economy. Teacher education courses are assumed to be useful tools, to at least advocate the preventive approach. However, there is a doubt whether “Social Studies, a Bachelor of Education programme and course taught in Nigerian Universities Teacher Education Departments and Colleges of Education will in its current form, in terms of content and method, be useful to “educate for sustainability”, which seems the right approach to doing it. Hence, this study investigates the learning content and perspectives from the course’s lecturer with a view to suggesting whether the course could or could not as it is currently; serve as a carrier-subject of the learning content of Education for Sustainability (EfS). 51 Bachelor of Education students who specialise in Social Studies and four Social Studies lecturers are purposively selected from one of the leading Nigerian Universities to respond to a questionnaire and attend to an interview by way of providing perspectives and understanding of concepts related to Education for Sustainability. The essence of this is to find out how best Social Studies could in its present form educate for social change, and to also find out what concepts it has and what concepts may need to be added if it has to perform this laudable role. A forty-item checklist and a 9-item questionnaire (used as student/lecturer questionnaire / structured interview) are used to collect data for the study. Findings of the study show that a lot of EfS concepts exist in, and are accommodated and currently taught within the selected Social Studies Teacher Education programme; and that although some EfS concepts do not have their exact names in the current Social Studies curriculum, there exist courses that may be modified or restructured to conveniently accommodate them. It also shows that a high percentage of the respondents agree that the EfS concepts are integral part of the current Social Studies teacher education curriculum, but are not sure if they understood the concepts; but, the few very relevant opinions submitted appear useful. Moreover, Social Studies lecturers in the selected university teacher education departments appear to reflect high degree of understanding of concepts related to Education for Sustainability. Lastly, Social

Studies Lecturers submit that the course already contains some of the learning contents of EfS (environmental education, values, attitudes, critical thinking, international interactions, sustainable development, poverty, colonialism, capitalism, to mention but few) and that the course may accommodate EfS concepts, but may not at present contain exactly some identified EfS concepts (such as energy, carbon-footprint, life-cycle, commoditisation, consumerism, fair trade, global citizenship, secure livelihood, to mention but few) or direct perspectives related to them. The study concludes that Social Studies is already accommodating EfS - but has to be reformed to include more emerging concepts, if it has to teach for values and skills that are useful for more sustainability concerns.

*Key Words:* Nigerian Social Studies Education Programme; Mainstreaming; Education for Sustainability Concepts

Number of Words: 6,140

## **Introduction**

In the last three decades, there have been noticeable concerns about several problems that are capable of having devastating effects on human beings and the ecological system upon which humanity depends (UNESCO, 2003). This has led to the emergence of the concept of “sustainable development”, defined by the World Commission on Environment and Development – WCED (1987, p.43) as “development that meets the needs of the present without compromising the ability of future generations to meet their own needs”. The problems identified as associated with the likely compromise are loss of biodiversity, deforestation and desertification, and pollution of various sorts which contribute to the overall problem of climate change (Carter, 2001: online). The general fear is that if the current trend of environmental degradation persists and increases, humanity might encounter an irreversible problem and disaster which it had not bargained for (Thalwitz, 1990. pp. xii-xiv). Hence, concerted efforts are not only made to put mitigative measures in place, but efforts are made to introduce preventive strategies (United Nations, 2005.p.130) which will not only sensitise people to the problems at hand but should also instil the right attitude in people. It is also hoped that such efforts will inspire people to minimise the impact that they create on the environment, which provides all means of sustenance to humanity. One of such approaches is the introduction of “Education for Sustainability”.

Sterling (1992) defines Education for Sustainability (EfS) as a subject that enables understanding and increases awareness and develops people's competence, attitudes and values in respect of the interdependence of all lives on the planet earth - because it allows vivid explanation of the repercussions of the economic, political, social, cultural, technological and environmental forces that are likely to foster or impede sustainable development. In other word, EfS seeks avenue to promote "thinking about" achieving quality of life and well-being for human kind and to enhance an achievement of satisfying lives for all, while staying within the bounds of nature (Chambers et al, 2000.pp.1-14.).

In the EfS practise, the keywords are reflective and critical thinking (Parker, 2008.p.3). This therefore makes EfS more unique and preferred to other adjectival disciplines (Sterling,2008. p.19) which have similar aims , such as, creation of awareness, inculcation of knowledge, attitude, skills and sense of participation related to environmental and sustainable development matters (WWF,2004. p.4). Such adjectival disciplines i.e. Environmental Education (EE), Development Education (DE), Education for Sustainable Development (ESD), Human Rights Education, and Global Citizenship etc are what Sterling (2008.p.34) calls "contributory approaches" to EfS. It therefore suffices to state that EfS may be a way of thinking, rather than a specialised area of study; hence, if the formal education systems get involved, every school subject could be adapted to educate for sustainability, and apparently "for change" as put by Sterling(2005.pp.4-5).

The concept of change here, may then mean a "realisation of", the fragility of the ecosystem, the unsustainable pattern of human development, unsustainable consumption, and the need for a shift in approaches to sourcing means of livelihood, with the environment as an important factor to be borne in mind when doing so (Macleod, 1992). If I have to put it in another language, I will subscribe to the opinion of Chamber et al (2000) that what is sustainable strikes equilibrium or revolves itself at the point where environment, society and

economy intersect. This therefore suggests that every school subject that will educate for sustainability should run an integrated curriculum that will promote systemic thinking (Sterling, 2005). An organisation with bias for sustainability, “Sustainable Measure” (2006) provides an example of a systemic thought, by saying that “communities are a web of interactions among the environment, the economy and society”; and that a single indicator cannot be used to measure sustainability. Hence "trying to run a complex society on a single indicator like the Gross National Product (economy) is like trying to fly a 747 with only one gauge on the instrument panel”. Sustainable Measure goes further that one could better imagine a medical doctor, who does not do more than checking only the blood pressure when examining a patient (Sustainable Measure,2006 : Online). By implication, I am of the opinion that sustainability can only be conceived following a critical examination of the interrelationships of society, economy and environment. Hence, people with interest in sustainability, including school teachers who will educate for sustainability are expected to bear this in mind.

Moreover, since EfS seeks to produce an attitudinal and behavioural change, and promote healthy lifestyles or civic renewal in people (Parker, 2008.p.50) and to enable them to participate actively in effective change-related decision making at local, national and global levels (Sterling,1992), a strategy which allows and seeks to promote cordial collaborative and critical examination of issues by the teacher and the learners, and which is employed in a mutually democratic atmosphere of trust and share of power and responsibilities (Friere, 1996) will be most appropriate to teach the subject matter of sustainability in the classroom.

However, because the issue of sustainability is just finding its way into the school and indeed the classroom in many places in the world (most especially in the UK), it may amount to a wild-speculation that it is “well accepted”, “well understood by respective teachers (in

terms of content and method)” or has been “effectively mainstreamed into existing school subjects” or had “existed on its own as a subject of study”. Ofsted (2000) provides a clue into an example of what likely obtains in the schools, especially in the United Kingdom. According to Ofsted,

*[t]he (UK) Government wants all schools to become ‘sustainable schools’ by 2020. (But when) Inspectors visited a selection of primary and secondary schools to assess teaching about sustainability and progress towards meeting the expectations of the National framework for sustainable schools(they found out that) [in] the best lessons, teachers used a range of imaginative activities to help pupils develop and test out their views on complex ethical issues. [They observed that]... most of the schools visited had limited knowledge of sustainability and work in this area tended to be uncoordinated, often confined to special events rather than being an integral part of the curriculum.(P.1).*

In fact, Ofsted seems to have captured it all, by its deduction that what obtains in the school may not be far from imagination of what the concept of sustainability implies. This (in my own opinion) may be because teachers were not trained about sustainability in their initial teacher education programme nor probably through a sort of in-service learning. Obviously, a teacher that does not have the knowledge of the subject matter may not be a custodian of the strategy for the teaching of any concept. She/he may then not be blameable for being uncoordinated in handling issues associated with the teaching of the sustainability-related subject in context.

In addition, because the idea of sustainability is now starting to creep into the school, it may be vulnerable to being subjected as a special event; whereas (in my own opinion), each concept in each school subject is expected to be a carrier of the subject-matter of sustainability which emphasizes the interrelationship between environment, society and economy. Similarly, I am of the opinion that the non-availability of a nationally approved “central curricular approach” may be responsible for teachers’ inability to teach well about sustainability, even though the teacher has the mandate to do so as it obtains in the UK. It is however assumed that if there is a central curricular approach on sustainability education,

teachers would not have other choices than to master it in content and strategy and hence teach the subject-matter appropriately.

Perhaps the Ofsted report appears alarming; and should we subscribe to the excuse of a lack of a central national curriculum titled EfS or ESD for possible use in the schools and colleges, we may not be facing the reality of the fact that the school is already overloaded: as teachers have so many things to cope with in their limited time schedules (Ivowi, 2000). But the idea of integration of elements of sustainable development into each subject's curriculum may be advantageous, even though it calls for some degrees of skilfulness on the part of the teacher. Besides that, OXFAM UK, a Non-governmental Organisation offers a consolation by developing a curriculum on education for sustainability called Global Citizenship (OXFAM,2008), which seems to be available to schools in the United Kingdom: so that the schools can teach about sustainability and not continue to depend on uncoordinated imaginative activities as observed by Ofsted. By this, schools in the United Kingdom may have something to fall back upon. But there seems to be none for Nigeria (where this study is carried out) and the issue of sustainability education is observed to be enjoying a lip service.

It should however be mentioned at this juncture that Nigeria is just retraining her teachers in achieving "Education for All", by preparing teachers for the implementation of the Universal Basic Education(UBE) - a programme integral to the Millennium Development Goals(MDGs),inclusive of sustainable development as its objectives. Regrettably, mention is not made of sustainability in any of the rationales for the introduction of the programme and even at the training in which I was a participant. Although it seeks to emphasize science and technology (which are development oriented), Social Studies and Civics (which seek to teach environmental education and citizenship respectively), it is not clear whether such approaches will make learners to be critical and reflective decision makers, because the contents of the

subjects do not seem to provide the mix required to be sustainability-minded; and the strategies seem not to be clearly spelt to bring about such results.

Besides that, an in-service training programme of the kind employed in UBE will normally elude young teachers of the future who are currently in the training, because the curriculum of the tertiary institutions have not been reviewed to reflect the new approach. Hence, there is the need to review the curriculum of initial teacher education to reflect this as a matter of responsibility. Wade (2000.p.3) supports this idea probably because sustainability education is an overarching issue for “the whole curriculum and the whole school ethos”; and that is why the school is expected to accept the responsibility to “maintain a sustainable environment for future generations”. According to Wade, this responsibility can only be fulfilled, if issues of sustainability become essential elements in initial teacher training.

Therefore given the fact that one of the school subjects in Nigeria, Social Studies (as a compulsory UBE subject), appears to have some bearing with sustainability because it studies human beings in the context of their interactions with the environment (Ajiboye, 1996), there may be a consolation that there could be an avenue to mainstream the facts and strategies of Education for Sustainability into the school curriculum in Nigeria. In the same vein, since Social Studies is taught in the University as part of the initial teacher education programme, efforts to mainstream EfS in concepts and strategies into pre-service teachers programme may probably be easy; and should this happen, graduates of Social Studies Education will not necessarily need any new in-service training about sustainability again, but would have been “trained-teachers” with a “holistic” view of the interrelationship of environment, society and economy and forge ahead to assist with the implementation of the Universal Basic Education programme when employed.

### **Problem of the study**



I am thinking that the current curriculum of the Nigerian Social Studies Teacher Education programme could educate for the required change i.e. making people to realise that the Nigerian ecosystem is fragile and vast diminishing, and that our approach to physical and human development and consumption must bear the environment in mind contingently in every planning phase of the national life - bearing in mind its multifaceted objectives, without necessarily mainstreaming any new concept into it. I also think its integrated nature may make it very capable of teaching for social justice and democracy – by being an embodiment of concepts embedded in sustainability; and that such concepts are relatively present in the current Social Studies programme of study at the teacher education level. But the degree of presence of such concepts, and the degree of understanding of strategies that can be used to teach to make pre-service teachers to acquire appropriate knowledge, understand related issues and perspectives, develop appropriate skills and values, by the Nigerian lecturers and students of Social Studies deserve being investigated. This expressed mind-set has therefore motivated some fundamental questions.

### **Research Questions**

1. Given the current curriculum content of Social Studies Teacher Education programme in Nigeria, does “Social Studies” stand in a better position to educate for sustainability?
2. What new perspectives (of EfS) can be integrated into the Nigerian Social Studies Teacher Education programme so that it can educate for change.

### **Methodology**

This study is an Action Research, premised on the ontology and epistemology of “critical theory” research paradigm. It is an action research because it seeks to suggest ways by which an identified problem can be resolved. An “action research” according to Plant (2005. p.60) is one of the particularly rewarding methodologies of education for

sustainability: because it “involves the researcher in a collaborative process of educational change aimed at bringing about a more sustainable, just and equitable world”. While Plant was providing clue into some of the possibilities for researching EfS through action research methodology, he listed examples of some activities that an EfS researcher can embark upon with a view to improving professional practice and also solve problems. Few of them are:

- Enhancing one’s professional competence and confidence by inspiring colleagues to develop educational opportunities that encourage their organisation to become more sustainable;
- Identifying new sites of environmental concern around sustainable practices that can be initiated and supported at the level of individual and community (ibid. p.63).

Guided by the critical theory research paradigm, I have identified a teacher education subject of study – “Social Studies”, because “it exists” as a course of study in the University in my country Nigeria, taught in the secondary and primary schools as a school subject and saddled with the responsibility of value and citizenship education. However, how good, relevant and detailed it is to educate for sustainability deserve to be determined. But the fact that it exists and recognised as a compulsory subject for citizenship, civic and value education provokes a critical study of its nature (scope and objectives) and its amenability to teaching an emerging subject – sustainability being an example. This perspective reflects the ontology of the critical theory research paradigm which states that what exists can be understood through communicative rationality based on consensus (Plant, 2005.p.76). Consensus in this context suggests prevailing opinions submitted from those who are involved in Social Studies teaching/ learning process especially at the teacher training institution where the content of the subject is theorised about and critically analysed for intellectual studies. Hence the objective of this study, which is to explain the nature of Social Studies as a subject that may be used for the communication of sustainability education indicates the need to realise that Social Studies as a subject actually exists.

By implication, how to go about the use of Social studies as a tool for sustainability education deserves to be known. This therefore calls for the exploration of the epistemology of the critical theory research paradigm vis-a-vis the utilisation of Social Studies to teach for sustainability in pre-service teacher education in Nigeria. The need for this arises because ontological assumptions give rise to epistemological assumptions which in turn give rise to methodological considerations, which also in turn give rise to issues of instrumentation and data collection (Cohen et al, 2007.p.5).

Cohen et al (2007.p.7) states that the epistemology of a subject-matter is the way by which its basis, nature and forms can be understood and communicated to other human beings. Hence, understanding Social studies as a tool for education for sustainability may involve its definition, scope and methodology with a view to examining what obtains in its contents and its outlined instructional approaches against criteria that are recommended for the teaching of subjects that convey the message of sustainability. Thus, going by the opinion of Plant (2005.p.76), critical theory research paradigm prescribes social conditions that favour dialogue and opportunities for fair assessment of truth. By implication, conducting an action research on how to mainstream EfS into a teacher education subject may require the involvement of those involved in its teaching/learning process (lecturer and student), who may be able to unveil what currently obtains in the subject (in terms of strength and weakness) so as to suggest ways by which it could be improved and become amenable for use as a carrier-subject of the content of education for sustainability. The foregoing therefore suggests the need for Strength, Weakness, Opportunities and Threat (SWOT) analysis, using students and lecturers of Social Studies in the selected University as sources of information. This thus leads us to the method employed for data collection i.e. design of this study, sample and sampling procedure and instrumentation (procedure for collection and data analysis).

## **Method**

## **Research Design**

The study is a qualitative action research inquiring into the strength, weakness, opportunities and threats of the current Social Studies teacher-education programme as a subject for training in education for sustainability. The dependent variable in context is Social Studies as a teacher training subject; while the independent variable is Education for Sustainability, whose content is corresponded with that of Social Studies to examine if Social Studies as it is, currently fit to educate for change. The study is guided by Sterling (2005) “Model of Staged Change” with a view to providing an Action Plan that may be suggested towards “accommodating” Education for Sustainability into the current Nigerian Social Studies programme: bearing in mind that the “response-ability” of existing Social Studies teacher-educators about education for sustainability as an instrument of change calls for .

## **Sample and Sampling Procedure**

There are currently about 200 Bachelor of Education undergraduate students in the Obafemi Awolowo University, Ile-Ife, Nigeria, which has been purposively selected as the centre for this study. The set of students (about 200) constitute the population for the study. The 400-level undergraduate students of Social Studies Education are purposively selected because they have offered virtually all course-units in Social Studies and are expected to have a lot of knowledge of scope and content of Social Studies. Suffice to say that none of the subjects (students of Social Studies) is expected to lack the requisite knowledge to assess what Social Studies should contain and what not, as a school subject that conveys the message of value and effective citizenship education (which are its main objectives and presumably part of the components of EfS).

Similarly, about 10 out of 16 Lecturers in the Institute of Education where the study is carried out are involved in teaching one course or the other in Social Studies at undergraduate level. Each and every one of them is expected to have a degree of

competence to explain what the subject is all about and identify which change it is to be effected in school students to promote the development of a sustainable future. They are equally purposively selected too.

### **Procedure for data collection**

Three instruments used for data collection are a questionnaire, a checklist for content analysis and the structured interview. Hence, the study uses a triangulation of methods (more than one method) for data collection. The characteristics of each of the instruments are discussed below.

### **The Questionnaire**

The questionnaire developed for this study is a structured one. It is meant to elicit responses from Social Studies Lecturers and University undergraduates who are studying to become teachers of Social Studies at the basic education level (Primary 1 to Junior Secondary 3) in Nigeria. As said under sampling above, it is assumed that the students might have been exposed to instructions in the fundamentals of Social Studies and might have learnt about some Social Studies concepts which may be conveying the message of sustainability, and about the integrated nature of Social Studies which may be promoting critical and systemic thinking that education for sustainability advocates. Therefore the instrument tests on what “systemic and critical thinking” may mean, and what sustainability may also refer to. It also tests on what should be the objective of a course curriculum that will educate for societal change; how competent is the current curriculum of Social Studies teacher education to educate for sustainability based on the lecturers’ perspectives; what could be added or removed from Social Studies in terms of content so as to make it more fit to educate for the kind of sustainability of their own perspective; what methods and strategies do they think could be employed to make Social Studies to become a tool for educating for sustainability. It is also assumed that the lecturers may be familiar with these concepts, apparently because

Social Studies is known to be an integrated subject and has concepts that are expected to achieve the national objectives of Nigeria, using education as a tool. Each of the lecturers is also asked to suggest how best they could break their teaching curriculum into twelve weeks of continuous lectures and two weeks of examination (a normal semester calendar) and how best they can make their courses to reflect critical, analytical, systemic thinking and other skills which EfS seeks to achieve as a subject.

### **The checklist**

A checklist developed for the study is meant to get an insight into a Nigerian Bachelor of Education Curriculum of Social Studies, specifically that which is developed, and validated by the Institute of Education, Obafemi Awolowo University, Ile-Ife, Nigeria and accredited by the Nigerian University Commission as a course of study at the teacher education level. The intention is to use the checklist as a tool for measuring its content-relevance, and comparing my own submission after the desk-analysis with information provided by other respondents engaged in the research. By this, it is expected that the possibility of further upgrade will be explored and a better approach to its organisation in content and method, may be suggested so that it may be relatively fit to educate for sustainability. The assumption is that a curriculum that teaches for value and citizenship could be fit to educate for sustainability. Such curriculum is also assumed to be integrated to such an extent that it can emphasize the interwoven relationship of environment, society and economy; and hence not stretch curriculum experts to seek another avenue for education for change/sustainability through introducing a new subject and/or by unprepared curriculum modifications.

The checklist is a 20-item instrument requiring the researcher to indicate with a tick against the options of “very related”, “related”, and “seems not related” on each of the items listed therein. The option selected is premised on the personal judgment of the researcher.

The checklist specifically examines each of the 25 core-courses in Social Studies with a view to verifying the presence or otherwise of concepts related to ecological sustainability (Energy, Cycles, Diversity, Community, Interrelationships, Change, Adaptation, Ecological Foot-prints etc) and human development( well-being, rights, political and cultural freedom, secure livelihoods, mutual respect, satisfying leisure hours etc) in the selected Social Studies Teacher-Education programme in Nigeria - with a view to identifying appropriate courses into which the concepts can be “accommodated” in the current Bachelor of Education course-unit system.

### **The structured interview**

The structured interview is an oral version of the structured questionnaire. It is meant to engage with lecturers of the course who seemed very busy to respond to paper documents. But when each of them is “captured” at a less-busy period, the researcher takes advantage of interviewing each of them. Its coding system is also similar to that of the structured interview.

### **Data Analysis**

All data collected are codified and subjected to qualitative analysis.

### **Results**

The thrust of this study is to investigate the possibility of mainstreaming the learning content of Education for Sustainability into Social Studies, a Bachelor of Education programme and course taught in Nigerian Universities Teacher Education Departments and Colleges of Education. The objective is to provide useful information that will assist curriculum planners, policy makers, subject associations and Social Studies experts to have some clues on the status of the current curriculum content of the Nigerian Social Studies Teacher Education programme vis-a-vis its ability to educate for change. Upon successful completion of this study, the findings below emerged.

**Research Questions 1:** Is the current Social Studies teacher education curriculum rich enough in content to educate for sustainability?

**Findings:**

The study shows that a lot of EfS concepts exist in, and are accommodated and currently taught within the selected Social Studies Teacher Education programme; and that although some EfS concepts do not have their exact names in the current Social Studies curriculum, there exist courses that may be modified or restructured to conveniently accommodate them.

**Research Questions 2:** Is the current Social Studies teacher education curriculum rich in content to educate for sustainability, based on the understanding of Education for Sustainability concepts demonstrated by the students?

**Findings:**

A comparably high percentage (47.06%) of the respondents submitted “Partially Meaningful” perspectives on what a course that will educate for positive change should seek to achieve. But the few “Very Meaningful” Perspectives (27.45%) they provide appear sensible. They demonstrate partial understanding (66.67%) of the concept, “education”, but have less understanding of “sustainability” (47.06%) as a concept. A comparably high percentage (50.98%) of the students could not define “Education for Sustainability” in their own perspectives.

A very high percentage (96.07%), 44.9% of which provided very meaningful reasons agrees that Social Studies could educate for sustainability. With regard to examples of the concepts that a course curriculum that will educate for sustainability should teach, the respondents commonly mentioned concepts that are integral part of the EfS curriculum. A high percentage of the respondents (40.2%) agree that the EfS concepts are integral part of the current Social Studies teacher education curriculum, but 54.31% are not sure if they understood the concepts. Indeed they demonstrated low level of understanding of the concepts. However, the few very relevant opinions submitted appear useful.



Moreover, higher percentages (76.19%) of courses identified are adjudged (plausible) to be amenable for the teaching of the identified concepts. In terms of method of teaching EfS concepts, a high percentage of the respondents mentioned “discussion method”. Sample topics mentioned seem plausible – could be taught with identified methods; while all the methods paired up with concepts are rated “likely to be useful” to teach the itemised EfS concepts.

### **Research Question 3**

- (i) Do Social Studies lecturers in the selected University Teacher Education Department have high degree of understanding of concepts related to Education for Sustainability?

#### **Findings:**

Based on the overall statistical summary of all “Very”, “Somewhat” and “Not” opinions expressed, Social Studies lecturers in the selected university’s teacher education department seem to be having high degree of understanding (73.75%) of concepts related to Education for Sustainability.

- (ii) How likely is Social Studies to be a carrier of EfS learning content based on opinions provided by the subjects’ lecturers in the selected university’s teacher education department?

#### **Findings:**

Social Studies Lecturers submitted that the course already contains some of the learning contents of EfS (Very True opinions=38.5%); and that the course may accommodate EfS concepts (Somewhat True opinions =29.5%); but that at present may not contain exactly the identified EfS concepts or direct perspectives related to them.

### **Discussions**

*Although global conditions suggest urgency in establishing Education for Sustainability broadly in society, the number of players engaged in (its) debate is still relatively limited, and it is by no means certain that EfS will move to the centre of educational debate in the next decade. The area is still under-*

*theorised and if it is to be influential, it needs to be more clearly developed, and it needs more practitioners and advocates. Certainly, just sticking the EfS label on existing practice without thinking through, won't be helpful or effective. The whole debate is in a formative stage, and this indicates (my) role, not just as a learner, but as an active participant (Sterling, 2005.p.1).*

The above quotation wets the appetite for this discussion of findings, and also strengthens the proceeding arguments that I have been making in respect of how to mainstream EfS into one of the teacher education courses (Social Studies), that is taught in universities and teachers' colleges in Nigeria.

The first opinion of Sterling in the above paragraph makes justification for why EfS should be given its urgent attention, bearing in mind the problems associated with climate change such as loss of biodiversity, deforestation and desertification, and pollution of various sorts (Carter,2001:online); and their irreversible problems and disaster which humanity might encounter (Thalwitz,1990. pp. xii-xiv). The envisaged (and of course currently materialising) problems are begging for attention, not only in terms of mitigation , but in preventive efforts too (United Nations,2005.p.130) - so that people would be sensitised to the imminent dangers, and by that they would develop right type of attitude to the environment.

Thus , as a learner and a participant in sustainability debate, I am duty bound to contribute not only to the debate about EfS, but to explore how I can engage my subject of practice (Social Studies) in the advancement of the frontier of knowledge of the subject matter of EfS in a developing country like my own, Nigeria. Hence, since I am an active participant in a teacher education department where the subject is theorised, researched and taught to train pre-service teachers on not only how to be effective citizens, but also to go forth and teach the younger generations in the secondary schools to be same, it is important to explore the possibility of using Social Studies as a carrier of the subject-matter of EfS.

Being in doubt whether the course Social Studies will in its current form, in terms of content and method, be useful to educate for sustainability; or put in another word, whether

the course could be modified/restructured to accommodate the subject matter of EfS ; I have investigated the content; sought students perspectives and also examined their understanding of EfS-related concepts. The study has also sought perspectives and examined the understanding of EfS-related concepts by other lecturers of Social Studies as well.

Having found out that a lot of EfS concepts exist in, and are accommodated and currently taught within the selected Social Studies Teacher Education programme; and that although some EfS concepts do not have their exact names in the current Social Studies curriculum, there exist courses that may be modified or restructured to conveniently accommodate them. It thus suffices to state that Social Studies may be a good course that could in the nearby future metamorphose to bear the title “Education for Sustainability”. My opinion is premised on Stephen Sterling’s (2005. Pp.79-80) Model of Staged Change, which explains that small circles (EfS) increasingly, affects the mainstream (large circles). Large circles here could be a programme, a course, or a policy. In this context, a course programme, Bachelor of Education (B.Ed.) degree in Social Studies.

If Sterling’s opinion is applied here, the findings of this study suggest that Social Studies is already accommodating EfS. It has “bolted on” sustainability ideas (e. g interrelationships, political freedom, human rights and obligations, diversity, well-being etc), even though limited to a single idea of effective citizenship which is just a little part in sustainability. Howbeit, it is better than nothing and can open the door to deeper change in the future. Thus, if the subject has to properly educate for sustainability, it has to be reformed i.e. it has to “build in” sustainability ideas to the existing system. By this, more coherent content have to be covered in order to teach for values and skills that are useful for more sustainability concerns. The findings of this study suggests that EfS concepts such as global citizenship, global trade, military spending, mutual respect, civil society, capitalism,

North/South relationships, justice and equity etc should be built into the Social Studies programme so that it could better educate for sustainability.

Similarly, in the event that the title or nomenclature of the subject has to change in the nearby future, excluding the fact that all concepts must be built in as above, where there is an overall redesign or change in policy, all concepts identified as “Not Inclusive(NI)” e.g. fair trade, protectionism, deep ecology, post-modernism, commoditisation, consumerism, neo-liberalism, etc should not be left un-integrated into the new outlook of the programme either in the title, Social Studies, or as Education for Sustainability or whatever course or subject nomenclature that it may bear. My opinion here is buttressed by the fact that the National Policy on Education (NPE) in Nigeria is aging, just as the society is also advancing. In addition to the emergence of Universal Basic Education programme and the need to achieve the Millennium Development Goals, there may be a shift in perspective of national life; and bearing in mind that the NPE has its roots in the goals and philosophy of the nation, apparently issues of critical concern will always have subjects or courses that will be saddled with the responsibility of handling the transmission of their knowledge and values.

Hence, if the Nigerian Education system will take charge of the transmission of knowledge and values associated with the interwoven relationships between environment, economy and society(Sustainable Measure,2006 : Online), and will promote “thinking about” achieving quality of life and well-being for human kind and to enhance an achievement of satisfying lives for all, while staying within the bounds of nature (Chambers et al, 2000.pp.1-14.), a course, programme or subject that is based on a realisation of the need for paradigm change must evolve. Such course, programme or subject should therefore emphasise process and quality of experiential learning, which is seen as an essentially creative, reflective and participative process (Sterling, 2005.p.81).

The opinion adapted from Sterling above, suggests that the method of teaching issues of sustainability must be learner-centred. This study has found out from students and lecturers of Social Studies that discussion method and other learner-centred methods are very efficacious in teaching EfS-related concepts. Their opinions agree with that of who opposes banking of knowledge and that of Fien (1993) who opines that methods that make students and teachers co-learners, afford learners the opportunity to construct social reality, and whose mode of classroom control is democratic are very suitable to educate for sustainability. Indeed, the result of the interview conducted on the fourth lecturer of Social Studies suggests that advance organiser strategy, and story-telling are very efficacious in teaching for sustainability and positive change. The respondent (fourth lecturer) specifically narrated a story which may be taken as an appropriate anecdote to teach obedience (See Ojedokun, 2010). His opinion agrees with that of Chapman (2001, p.260) that effective campaigns are based on oral history (making and telling stories), and as such, they draw in new supporters. Supporters, in this context, can then be undergraduates of Social Studies or EfS programmes, who also in turn “disciple” others on the basis of what they have acquired in an experiential classroom. Suffice to say that, issues of Education for Sustainability revolve around meaningful and relevant learning content and participatory teaching/learning methods.

## **Conclusion**

Based on the findings of this study it may be concluded that Social Studies is already accommodating EfS. It has “bolted on” sustainability ideas. But has to be reformed to teach for values and skills that are useful for more sustainability concerns - through building in concepts such as global citizenship, global trade, etc, if it will properly educate for sustainability. The study also observes that issues of Education for Sustainability revolve around meaningful and relevant learning content and participatory teaching/learning

methods; and that the current Social Studies teacher education programme in Nigeria has a load of teaching methods from which an EfS subject-matter teacher can select to teach.

## **Recommendations**

Premised on the above conclusion, it is recommended that Social Studies lecturers, its curriculum experts and subject associations should ensure that the course is reviewed periodically, so that every emerging concepts (especially those that address sustainability) could be integrated and taught, not only to pre-service teachers, but also to younger generations who finally benefit from the knowledge that have been acquired by the trained teachers in the teachers' colleges and universities. It is also recommended that there should be proper training in methods of teaching at the teacher training institutions; so that a generation of teachers who are very versatile in the use of appropriate teaching methods for appropriate topics/concepts/themes are raised for the teaching of concepts that promote sustainable society. Lastly, a replication of this study and or widening of its cope to confirm or disconfirm its findings is highly recommended.

## **References**

- Carter, N. (2001). *Understanding Sustainable Development*. Available online Tuesday 8 July 2009 from <http://www.fathom.com/course/21701763/index.html>
- Chambers, N. et al (2000). Redefining progress. In Chambers, N. Et al. *Sharing nature's interest*. London: Earthscan. Pp.1-14.
- Chapman, J. (2001). 'The importance of people on the ground in international campaigns'. In Lewis, D. & Wallace, T. (eds) *New roles and relevance: development, NGOs and the challenge of change*. Connecticut: Kumarian Press.
- Cohen et al. (2007). *Research methods in Education*. London: Routledge. p.7.
- Fien, J.(1993). Major characteristics of vocational /neoclassical, liberal/progressive and socially critical orientations in education". In Parker, J. (2008) *Unit 1 Reader – Introduction to Education for Sustainability*. London: Distance Learning Centre, London South Bank University. Reading 6.
- Friere, P. (1972) *Pedagogy of the oppressed*. London: Penguin.
- Macleod, H. (1992). *Teaching for ecological sustainable development*, Department of

Education, Queensland.

Ofsted (2000). *Schools and sustainability - A climate for change?* London: Ofsted.p.1.

Ojedokun, O.E. (2010). An “Old Skin” for a “New Wine”: An Education for Sustainability action plan for a Nigerian Teacher Education programme. *Unpublished M .Sc. Dissertation* submitted to the London South Bank University, London, England.

OXFAM (1997). *A curriculum for global citizenship*. Oxford: Oxfam.

Parker, J. (2008). *Unit 1 Study Guide – Introduction to Education for Sustainability*. London: Distance Learning Centre, London South Bank University.p.34.

Parker, J. (2008). ‘Situating Education for Sustainability: a Framework Approach’. In Parker &Wade, R. (eds) (2008). *Journey Around Education for Sustainability*. London: London South Bank University. p.6.

Plant, M. (2005). *Researching Education for Sustainability* .London: London South Bank University, Faculty of Arts and Human Sciences. p.60.

Sterling, S. (1992). Environmental Education and Environmental Policy. A good alliance. . In Huckle, J. and Sterling, S. (2008). *Education for Sustainability*, London: earthscan.

Sterling, S. (2005). *Unit 7 Study Guide: Education for Sustainability. Education in Change*. London: London South Bank University. p.1.

Sterling, S. (2008) Education in change. In Huckle, J. and Sterling, S. (2008) *Education for Sustainability*. London: earthscan. p.24. Ibid. p.25.

Sustainable Measure (2006). *What is an indicator of sustainability*. Available online from <http://www.sustainablemeasures.com/Indicators/WhatIs.html>.

Thalwitz, W. P. (1990). Foreword. In Kreimer, A. & Munasinghe, M. (eds) *Managing natural disasters and the environment*. Washington: Environmental Policy and Research Division. Environment Department, The World Bank. Pp. xii-xiv.

UNCED (1992). *Promoting education public awareness and training*. Chapter 36, Agenda 21. London: Regency Press.

UNESCO (2003). The Decade of Education for Sustainable Development: framework for a draft international implementation scheme, Paris, Unesco.p.27.

UNESCO (2003). United Nations Decade of Education for Sustainable Development (January 2005-December, 2014). *Framework for a Draft International Implementation Scheme*, July. Paris: UNESCO.

United Nations (2005). *Building the resilience of nations and communities to disasters – Proceedings of the World Conference on Disaster Reduction*. 18-22 January 2005, Kobe, Hyogo, Japan. p.130. (Online) Available

from:<http://www.unisdr.org/wcdr/thematic-sessions/WCDR-proceedings-of-the-Conference.pdf> [Accessed 10 July 2009]

United Nations (2005). *The United Nations Decade of Education for Sustainable Development*. Japan: Nations Centre. p.130.

Wade, R. (2008). *Journeys around education for sustainability*. London: London South Bank University, Faculty of Arts and Human Sciences.p.24.

WCED (1987). *Our common future*. Oxford: Oxford University Press. p.43.

WWF (2004). *Pathways: A development framework for school Sustainability*. p.4.



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**Decentralised, Global Networks: A framework for multi-scaling education for  
sustainable development**

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Track 3a. Institutional arrangements and stakeholder co-operation for sustainable  
development at multiple scales

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Globalisation is implicated as a driver of many sustainability issues, but it also changes the way these issues are understood and can provide the tools for addressing systemic problems that have so far eluded smaller-scale approaches to sustainability learning. Certainly, globalisation has a range of implications for the development and implementation of contemporary Education for Sustainable Development (EfSD) including: (1) increased emphasis on the global and intractable nature of many sustainability issues (e.g. climate change, land degradation, poverty) towards a focus on approaches that can effectively link local and global scales; (2) greater access to information and communication technologies that can support information exchange and educational programs across ever-increasing distances; and (3) the development of a broader scope for educational investment from outcomes based around individuals to opportunities for societies and even nations. In particular, an emerging trend has been the application of decentralised, global networks in the development, operation and implementation of EfSD programs. However, there is little documented evidence of the success of such recent approaches or of the inherent barriers and opportunities in scaling up EfSD programs from the local to the global scale. This paper examines quadruple bottom line approaches and theories of scalability in the development of a theoretical framework for non-profit organisations and global networks to evaluate the strategies for, and outcomes of, EfSD programs delivered through decentralised, global networks.

Keywords: decentralised organisations, education for sustainable development, educational investment, globalisation, information and communication technologies, monitoring and evaluation, non-profit, scalability, sustainability learning.

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## **Introduction**

Increasing recognition of environmental, economic, social and governance issues on a global scale facilitated by advances in information and communication technologies (ICT) are significant features of what has been termed globalisation (United Nations, 2003). These trends have also changed the education demands of individuals, organisations and nations, whereby education is increasingly considered an investment in the collective future of societies and nations, rather than simply the future success of individuals (UNESCO, 2002). This has implications for the way educational programs are conducted—particularly those of international significance and that require an effective combination of local and global perspectives—such as those characteristic of Education for Sustainable Development (EfSD). An emerging trend in such fields has been the use of decentralised, global networks to develop and operate educational programs as communication technologies improve and the benefits of diverse and global perspectives are realised. Nevertheless, this is a recent approach and there is little documented evidence of the success of such approaches or of the inherent barriers and opportunities experienced.

Not-for-Profit Organisations (NPOs), including Non-Governmental Organisations (NGOs), and International Non-Profit Organisations and Associations (INPOs/INPAs), have adopted decentralised global network approaches in the pursuit of education for sustainable development (EfSD) program facilitation. NPO's aim to facilitate positive change within communities across a variety of scales, with a mandate for un-coerced, collective action around shared interests, purposes and values (London School of Economics and Political Science Centre for Civil Society, 2006). As Laurance et al (2001:1) note, 'collectively, these programs involve hundreds of millions of dollars and the energies of many dedicated individuals'. During the past few decades NPOs have grown in size, number and reach. Their interventions have been instrumental in the resolution of many issues facing businesses and governments (Doh and Teegen, 2003). For example, approaches to energy production and emissions and the equitable treatment of foreign workers have been advanced by the input and interventions of NPO's. On an international scale, individuals, organisations, and governments provide resource inputs to NPOs based upon both perceived social need and assumptions regarding their ability to facilitate positive outcomes in political, social, and/or environmental areas. McKinney (2004:1) states that 'the new competitive environment, rising cost of governmental programs, and citizens' demands for a better and more cost-effective delivery of goods and services are forcing public managers and others in non-for-profit organisations to make creative use of scarce financial resources'. For example, over the past several decades non-governmental organizations (NGO) have pioneered the initiative of providing finance to the poor to help alleviate their poverty and improve their socio-economic conditions. Access to basic needs of, for example, shelter, safety and clean drinking water, are under pressure and the dependence of NGOs on donor financing hinders the sustainability and continuity of activities to provide for these needs (Chahine and Tannir, 2010:2). NGOs are also facing increased competition from both privately owned companies and an every expanding number of non-profits to a limited pool of funding, whilst confronting escalating societal needs, hostile environmental forces and serious sustainability concerns (Chahine and Tannir, 2010) which, regardless of their ability to address them, continue to proliferate.

The twin pressures of globalisation and an ever-increasing societal need present challenges that will require a systemic approach to be applied if they are to be adequately addressed. Sterling (2003:40) presents a fundamental argument that 'issues that surround us are fundamentally systemic' and, therefore, 'we need to think and learn systemically'. There currently remains limited literature examining how systemic approaches impact upon sustainability learning, and more specifically, how decentralised networks operate as global organisations facilitating EfSD across scales, scaling up from local to international projects/initiatives. Use of analogies such as scaling up and scaling out, as they relate to

educational programs, ‘conjure images of mass production of a tangible product so one can go from a local to a regional or a national market, creating illusions about the nature of the processes necessary’ (Elias et al., 2003:304). The widespread implementation of effective EfSD programs require ‘thoughtful realism’ about how scaling programs up and/or out can be ‘important, difficult, and possible’ (Elias et al., 2003). Important questions in regards to the scalability of EfSD programs have not been properly addressed. An examination of the core concepts of globalisation and scalability will assist in framing the theoretical foundation upon which the development of a nested, systemic monitoring and evaluation framework that studies and accounts for a decentralised, global network will be formulated.

## **Globalisation and Global Networks**

For the purposes of this research globalisation is fundamentally defined as the increasingly influential structural changes occurring in the production and distribution of educational programs at a transnational level. As indicated by Knight and de Wit (1997) globalisation refers to the increasing flow of technology, finance, trade, knowledge, people, values, and ideas across borders. There exists now a world that is globally connected and which justifies and requires organisations and projects to operate across and be influenced by international politics, movements, governance structures, and cultural nuances. EfSD is an emerging, knowledge-based service/product that may increasingly be transacted by non-governmental organisations (e.g. NPOs, NGOs, and INPAs) within and across borders. ‘NGOs have complex geographical ranges and, in addition to being connected to one another, often are entangled with state or quasi-governmental agencies, as well as with businesses’ (Roberts et al., 2005:1845) as is, for example, the case of the Environment and Schools Initiative (ENSI) which for many years was a project auspice by the Organisation of Economic Co-operation and Development (OECD) and heavily reliant upon their support. Orr (1992) identified that this ‘Westphalian’ system functioned best in the early to late 1800’s when the ‘actors were all nation states of roughly the same size and geographical location (i.e. Europe). The geo-political structure now in evidence is ‘a world system consisting of political systems, cultures and non-state actors’ (Orr, 1992:44).

A steady and increasing pace of technological development will continue to accelerate the degree of globalisation and acute impacts upon organizational development and delivery. Non-profits face increasingly stringent performance requirements inclusive of an expectation of efficiency, quality, speed, flexibility, and innovation (Bolwijn and Kumpe, 1992 cited and translated in Bouwen, and Taillieu, 2004:3). Gradually, the challenge of design, development and facilitation of projects that identify with multiple, and often regionally dispersed, stakeholders has become a challenge of encouraging systemic simplicity whilst trumping complexity. Tools that assist in the facilitation of EfSD projects, for example, communication technology (i.e. tele-presence), document transfer, and faster and more-cost efficient travel, have all made the implementation of cross-border, decentralised project teams, and international projects progressively more accessible to a myriad of organisations and stakeholders (Cogburn, 1998).

At a more conjunctural and secondary level, globalisation is affecting all of the social, political and economic structures and processes that emerge from this global restructuring. One critical issue that emerges from all of these restructuring processes is the central role of knowledge, education and learning for the success of the Global Information Society (GIS) and global information economy. Knowledge is becoming an increasingly important factor of production. More important, some analysts would argue, than land, labor and capital (Cogburn, 1998:1).

Parrish (2007:1) argues that ‘there is a growing appreciation that it is not human technology so much as patterns of human activity that is challenging the sustainability of human development’. Demonstrating the contradictory nature of globalisation, the sustainability movement itself has grown into a key instrument within the globalisation process, with activists using global networks such as internet-based social media to organise international demonstrations against global processes that include the practice of transnational corporations and international free trade regulations (Krishna, 2008; McGrew, 2007; Meyer, 2007; Sachs, 2000). The emerging Global Information Society and information economy, and the resultant development of novel ‘patterns of human activity’ evolving from these developments, hold implications for EfSD throughout the sustainability learning process providing justification for further research into the impact that globalisation and decentralised networks have upon the scalability of organisations and projects. The Internet, for example, is a significant enabler of scale and may actually be the most powerful tool to hit humanity since the advent of agricultural communities. The explosive growth of global virtual communities of people united across borders, race, sex, religion, etc. by interests and beliefs, and the nearly instantaneous ability to share ideas is the kind of transformative tool that would legitimately be considered a leverage point (Van Peborgh, 2008).

### **Supporting Information Exchange through Globalisation**

The advantages of technology are not found in creating new "virtual" communities, but in strengthening already existing social networks (Van Peborgh, 2008). Perhaps one of the biggest challenges facing agencies and other information managers today is how best to involve different interest groups in taking a more active participatory role in the subsequent management of this information, and through this to improve planning, policy analysis and decision making. While many networking sites have always aspired to this, the advent of the Web 2.0 technologies (e.g. wikis, blogs, Content Management Systems, etc) are facilitating this more interactive web future. ICT developments, which enable globalisation and a dramatic move towards real-time organisation, evoked the perspective of learning in organisations and society (Bouwen, and Taillieu, 2004:4). Developing projects scaled through diversification, increasing activities and broadening indirect impacts of the organisation (Uvin *et al.*, 2000) are influenced by the impact that ICT can have upon the relative size and reach of projects. However, it should be noted that ICTs can only help to achieve sustainable development and EfSD. They are a means and not an end in and of themselves.

With an ever increasing competitive market for non-profit funding and the introduction of information technology in advancing and leveraging communication between geographically dispersed organisations there is a seemingly endless supply of knowledge flow and transfer between organisations and nations. An increasing focus upon knowledge services as ‘transactionary’ has impacted upon both the governance and operation of non-profit and/or decentralised organisations. Organisations with the potential for extension of their ‘global reach’, particularly those competing in community-oriented sectors (e.g. education and the environment) have increasingly expressed the tendency to explore global reach options utilising something akin to the emerging Innovation-Mediated Development Model (Kenny and Florida, 1993). This model is grounded in the ‘blurring of the distinctions between mental and physical labour and the increase in the application of knowledge to the production process itself’ (Cogburn, 1998:2); thereby, in contrast to the predominant 20<sup>th</sup> century Fordist-Taylorist Model which focuses upon the mass production and linear use of labour. Cogburn (1998:2) states that the ‘incessant technological development of the new techno-economic paradigm, the convergence of telecommunications, computers, and broadcasting, along with the increased pressures for global deregulation, liberalisation and market-access have radically altered the global political economy’. Globalisation is not a qualitatively new

phenomenon, but a tendency which has always been integral to growth (Hill, 2005). Hallak (1998) identified globalisation as a combination of much freer trade in goods and services combined with free capital movements. The proliferation of 'free-market' trade and the blending of global, transactional boundaries have led to an expansion of traditional trade markets and rapid expansion of 'globalised' society. Globalisation provides an enabling platform for the development of learning mediums that drive decentralised initiatives and agendas. This system of connectivity enhanced by increasingly accessible technologies provides opportunities for global networks to connect with the systems and process required to enable EfSD to be effectively facilitated at local, regional, national and international scales. Gibson (2006) believes that technology will drive the development of an increasingly systemic public commons.

Technology is seen by many as one of the most promising venues for encouraging, facilitating, and increasing citizen-centered dialogue, deliberation, organising, and action around a wide variety of issues, but it has been relegated to the side-lines in many of the public discussions about service and civic engagement (Gibson, 2006:19).

Essentially, EfSD is an integral component of a broader civic movement and technology now plays a fundamental part in the success of this movement. The use of varying learning mediums (e.g. ICT) addresses a few of the barriers faced by INPAs operating on a global scale: specifically, access to markets and distribution channels. The development of learning mediums that both take advantage of and enhance technology may not prove to be a revolution in and of themselves, however, may yet present a platform for civic driven, EfSD on a global scale.

Globalisation and ICT are intrinsically linked. Globalisation facilitates the proliferation of ICT and ICT acts to manage and expedite the growth of globalisation. More recently, practitioners and scholars alike are beginning to recognize that good management goes well beyond program implementation. In fact, effective management is integrally linked to well-designed monitoring and evaluation systems (Margoluis, and Salafsky, 1998; Woodhill, 2000; Stem *et al.*, 2005) that account for the impact of globalisation upon program delivery. The theoretical framework developed in this research seeks to address this gap in the literature and make explicit the integral part monitoring and evaluation of operational and organisational management, in addition to the EfSD programs themselves, play in the scalability and the facilitation of EfSD programs and the decentralised organisations that develop and support them.

## **Educational Investment**

In terms of educational governance, the globalisation of educational delivery is the predictable outcome of capitalism's expansionary tendencies (Hill, 2005) and a challenge in which many decentralised organisations now face. NPO and funding bodies (e.g. governments, private enterprise and individuals) are increasingly evaluating the outcomes of such funding and associated projects as the accountability of NPOs becomes progressively more important. Conventional management approaches seem to operate from the assumption that non-profit organisations have no bottom line. 'In the for-profit world, there are market prices for goods and services linking sellers and buyers, wages linking employers and employees (collective bargaining), profits linking shareholders and management, and taxes linking the firm with the general public represented by government' (Anheier, 2000:6). Not-for-profits answer to similar hierarchies of accountability and, as such, must regard traditional management and neoliberal approaches as drivers of their governance and operational strategies.

Accountability and reporting, concern about taxes, and efficiency concerns in activities should be easily measurable and quantifiable to ensure funding is attracted and outcomes are met (Anheier, 2000). For example, Conroy (2005) notes that the findings of Auditor General (AG) Reports on NPOs in Victoria, Australia where an audit in the year 2000 of significant grants to NPOs revealed ongoing, unresolved management and accountability issues from two previous AG audits in 1986 and 1994. Convoluted and inherently misaligned monitoring programs do not lend themselves to convincing accountability, program resilience or ongoing funding support. Currently, monitoring and evaluation are often a secondary project and, if taken into account from the project outset, comprise only a small part of the project funding, planning, and development. This could be attributed to NPOs having discovered that there are heavy administrative costs associated with meeting accountability requirements (Conroy, 2005).

### **A Whole Minded Aptitude**

A key aspect for linking the concepts of globalization, EfSD, accountability and monitoring and evaluation together in a concise manner is to ensure a holistic and systemic framework is applied; however, simplified enough to be conducive to being applied with scale. Making connections from local to global (e.g. localised flooding relating to climate change) is difficult without common values and ethical frames. Differing, for example, demographic, external, and internal factors will have an impact (positive or negative) on the models of pro-environmental behaviour which will be demonstrated by two different people both from an individual and collaborative perspective (Kollmuss and Agyeman, 2002). Kollmuss and Agyeman (2002:240) identify a number of factors found to have some influence, positive or negative, on pro-environmental behaviour such as 'demographic factors, external factors (e.g. institutional, economic social and cultural factors) and internal factors (e.g. motivation, environmental knowledge, awareness, values, attitudes, emotion, locus of control, responsibilities and priorities). For example, two demographic factors that have been found to influence environmental attitude and pro-environmental behaviour are gender and years of education. These factors can have a direct effect upon social learning and the channels in which it is facilitated as a result of their link to the access to knowledge and understanding required to make decisions. The concept of social (collaborative) learning refers to the learning processes among a group of people who seek to improve a common situation and take action collectively. Social learning theory approaches the explanation of human behaviour in terms of a continuous reciprocal interaction between cognitive, behavioural, and environmental determinants (Bandura, 1977). According to Milbrath (1989) social learning occurs when a dominant institution is replaced by another referring to changes in societal practices and norms that are shared by a large number of stakeholders. Social learning can be frequently individual-centric in nature as it focuses on an explanation of human behaviour within a, and often consequential of, group interaction. Sustainability learning considers that people learn from one another, including such concepts as observational learning, imitation, and modeling.

In contrast to the notion of social learning in general, sustainability learning focuses on the process of generating and applying a specific type of content of what is learned. In particular, sustainability learning relates to learning to develop the capacity to manage options for the adaptation of human societies to the limits and changing conditions that are imposed by their own social-ecological systems (Tàbara and C. Pahl-Wostl, 2007:11).

Sustainability learning entails becoming increasingly aware of the limits and of the unintended negative consequences of collective action. The subsequent shared learning often results in what Bouwen and Tallieu (2004:7) refer to as communities of practice in which

actors engage in joined activities, and by doing so form a common problem understanding and a common experience of some group identity. In the process of shared learning, people develop the adaptive capacity to systemise, manage, and deliver change. Sustainability learning, as it relates to the development of communities of practice, may be a significant driver of, and sometimes challenge to, the scalability of EfSD programs and the organisations that deliver them.

### Management through Multi-scaling

Scalability involves adapting an innovation that is successful in a local setting to effective usage in a wide range of settings and contexts. In contrast to experiences in other sectors of society, scaling successful programs has proved very difficult in education (Dede, Honan, and Peters, 2005). A combination of economic, objective and developmental motives makes a good justification for scaling up EfSD projects. However, the question remains how to scale up successful projects in a cost effectively manner (Catacutan, 2005). In respect to scalability, a concept not yet investigated in great detail as it relates to EfSD, interventions and policies required to meet the DESD objectives will demand long-term investments in management systems, training and retention of human resources, and infrastructure. For example, collaboration in training is recommended as means to scale up the delivery of education (Cogburn, 1998; GIIC, 1998). ‘In many instances, non-governmental organisations will be best placed to deliver rapid scale-up’. (Sachs and McArthur, 2005:350).

Scalability of projects and the organisations that deliver them is a multi-tiered process. Uvin (1995), for example, suggested that scaling up is about expanding impact and not just becoming larger. Uvin (1995) identifies four types of scaling:

**Table 1. Quadruple Bottom Line (Four Types of Scaling)**

Type	Description
<b>Quantitative (Governance)</b>	A program or an organisation expands its size by increasing its projects or constituency through increases in geographic area or budgets.
<b>Functional (Financial)</b>	An organisation expands the number and the type of its projects. For example, from EfSD to sustainable development consulting, etc.
<b>Political (Environmental)</b>	The organisation moves beyond service delivery towards empowerment and change in structural causes of underdevelopment. This usually involves active political involvement and the development of relations with the state.
<b>Organisational (Social)</b>	Organisations increase their organisational strength to improve the effectiveness, efficiency and sustainability of their activeness. This is through diversifying fund sources, increasing level of self-financing/income generation, assuring the enactment of public legislation earmarking entitlements within the annual budgets for the program, creating external links with other organisations, or improving internal management capacity of staff.

Adapted from Uvin (1995)

A combination of the above four types of scaling is often required to provide an overall net gain in scalability and program development, and increase the impact of the organisation and its projects. These net gains can be accomplished through: 1) expanding the coverage and

size of the organisation; 2) increasing activities and projects; 3) broadening indirect (i.e. other stakeholders) impacts; and, 4) enhancing and ensuing organisational sustainability (Uvin *et al.*, 2000).

There is also a requirement for scalability to be implemented via a two dimensional approach of vertical and horizontal scaling. As an organisation advances higher up the institutional levels (i.e. vertical scaling up), the greater the chances for horizontal spread; likewise, as one spreads farther geographically (i.e. horizontal scaling out), the greater the chances of influencing those at the higher levels. The two main dimensions of scaling are defined as:

- 1) Vertical Scaling Up is institutional in nature that involves other sectors/stakeholder groups in the process of expansion – from the level of grassroots organizations to policymakers, donors, development institutions and investors at international levels.
- 2) Horizontal scaling out entails geographical spread to cover more people and communities and involves expansion within same sector or stakeholder group. Achieving geographical spread is also realized through scaling down – increasing participation by decentralization of accountabilities and responsibilities particularly in breaking down big programs into smaller programs/projects (Committee Consultative Group on International Agricultural Research, 1999).

Scalability, as an organisational concept, is much more impactful if it can serve as an example for other communities across the globe to emulate. Scalability in and of itself can be evidence that an idea is sustainable, at least in the more traditional sense of the word (Catacutan, 2005). The concept of scaling could be validated and ‘benefit from an evaluation of program effectiveness. This could be started by looking at the advances made towards meeting a program’s objectives, as well as an analysis of conditions predisposed to successful implementation’ (Catacutan, 2005:4). An adaptation of the Programs Context and Pre-conditions Matrix (Table 2) would assist the early identification of a projects predisposition to scalability.

**Table 2. Program Context and Pre-Conditions Matrix**

<b>Key Characteristics of the Program (Program Context)</b>	<b>Fundamental Conditions</b>	<b>Essential Conditions</b>	<b>Negotiable Conditions</b>	<b>Non-negotiable Conditions</b>
<b>Participatory</b>	High relevance to potential users	Sense of volunteerism and participation values	Participatory approaches, pre-existing human or social capital	Facilitation skills, capability building activities
<b>Information oriented</b>	Availability of Information-equipped institutions	Participatory generation of appropriate technologies	Dissemination approaches (e.g., stakeholder-to stakeholder, etc.)	Continuous flow and sharing of information
<b>Key Stakeholder-focused</b>	High program relevance to key stakeholders	Participation, unity and cooperation, sense of	Pre-existing human and social capital	Training, capability building and facilitation



		solidarity		
<b>Based on partnerships</b>	Government support	Other institutional support	Pre-existing partnership schemes	Convergence of common interests and goals

(Adapted from Catacutan, 2005)

Scalability in the context of EfSD is the property of reducing or increasing the scope of education and learning methods, processes, and management according to the project size and reach. One way of assessing scalability is with the notion of scalable adequacy—the effectiveness of an EfSD framework or process when used on differently sized problems. Inherent in this idea is the capability to scale the process to particular project needs, contractual requirements, or even to budgetary and organisational goals and objectives. ‘Indeed, every setting already contains roadmaps of how innovations have successfully scaled, or failed to do so. The quality of implementation needs to be monitored and described, including the planned and actual intervention, and the planned and actual implementation support systems (Greenberg et al., 2002).

The concept of scalability has been identified as a significant gap in EfSD research. There is a developing collection of literature (e.g. Tilbury, 2006, 2007, and 2009; Klauer, Drechsler, and Messner, 2006; Bellamy, et al., 2005; Stem et al., 2005; and Margoluis and Salafsky, 1998) investigating EfSD indicators development, monitoring, and evaluation. However, there remains a limited amount investigating the scaling of EfSD programs. If research and development institutions are to close this gap, research into scalability should be high on their agenda (Catacutan, 2005:1).

## Emerging Themes

Early research into EfSD scalability has been conducted through document analysis and macro-level (organisational) key informant interviews comprising the initial phases of the data collection for a much more comprehensive research project. Early data analysis provides an insight into the barriers and opportunities to scaling up, out and in of EfSD. Key themes include:

1. Governance and accountability.
2. Relevance to stakeholders.
3. Implementation and the role of the organization (e.g. academic, practical or both).
4. Funding and economic resilience.
5. Strength of networks and collaboration

These themes lend support to an emerging theoretical framework will be discussed in the sections below.

## A framework for Scaling Up, Out and In

The framework developed is grounded in current and emerging national and international sustainability drivers. For example, in Australia providing effective EfSD has recently been endorsed as an imperative in all states and territories and is guided by the ‘National Action Plan’ documents ‘Educating for a Sustainable Future (2005)’, and, the recently released ‘Education for Sustainable Development’ (NAP ESD, 2009) - the latter having been developed to supersede the preceding document. From an international perspective the Millennium Development Goals (MDG) identified promoting education and environmental sustainability as integral to achieving the MDG plan and realising the quantitative targets set for the year 2015 (Sachs and McArthur, 2005). The ‘scale-up of interventions and policies required to meet the MDG will demand long-term investments in management systems,

training and retention of human resources, and infrastructure (Sachs and McArthur, 2005:350)'. This is a result of the increasing pressures to account for resources and to demonstrate that they are important investments of public assets. A combination of economic and developmental motives makes a good justification for scaling up.

'Scaling up research has been tenuous because scaling up efforts are, in the first place, generally initiated with development goals, rather than with research goals, showing the separate worlds of research and development. The knowledge-base generated from scaling up research would make a contribution to further scale up the impacts of appropriate technologies, programs or strategies' (Catacutan, 2005:2).

Mindful of the recent imperatives and drivers, the ensuing theoretical monitoring and evaluation framework seeks to address the gap recognised between knowledge (i.e. research) and behaviour (i.e. implementation) apparent in the scaling scalability of EfSD projects.

The development of the conceptual framework is guided by the goals and mission statements of the current United Nations Global Monitoring and Evaluation Framework and the Decade of Education for Sustainable Development (UN-DESD, 2005-2014). As such the conceptual framework will seek to address the following key points as outlined by Tilbury (2009) in her review of the progress of these initiatives:

- Raise awareness amongst stakeholders about ESD and the DESD itself;
- Provide opportunities for reflection and learning;
- Monitor progress across a range of sectors; and
- Assess changes in context and structures; processes and learning; as well as outcomes and impacts.

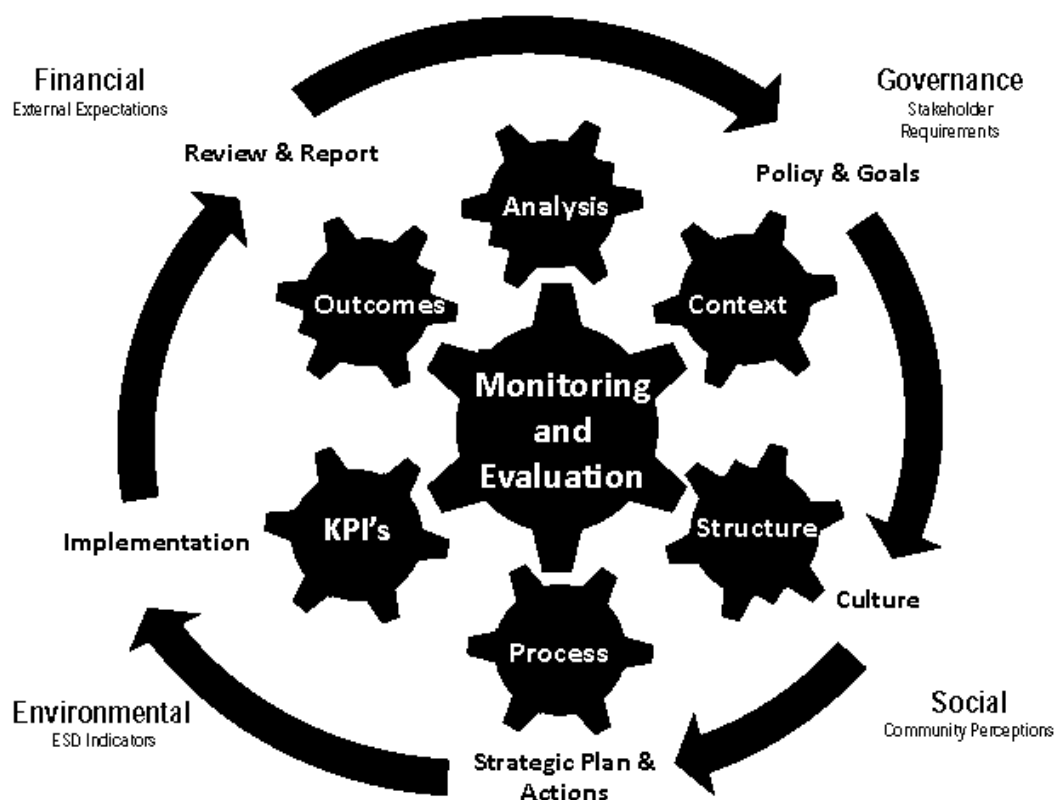
Monitoring and evaluation mechanisms have an inherent capacity to provide valuable information for all stakeholders in regards to the success and/or predicted success of EfSD programs and initiatives (Klauer, Drechsler, and Messner, 2006). As highlighted by Tilbury (2007:8), the UNECE Expert Group defined ESD indicators as having the ability to 'point to an issue or condition'. In particular, indicators are important as they can direct attention to a part of a system and/or system as a whole that is not always visible or easily measured (Eder, 2004). Thus, the framework developed in this research is consistent with specific strategies detailed for the UNDESD International Implementation Scheme (IIS) and holds as a central goal providing assistance in determining potential future directions or EfSD programs and initiatives.

There is growing recognition that good organisational and project management is integrally linked to well-designed monitoring and evaluation systems (Stem et al, 2005). For example, 'the core challenge of the MDGs is in the financing and implementation of the interventions at scale. Scale-up needs to be carefully planned and overseen to ensure successful and sustainable implementation' (Sachs and McArthur, 2005:350-351). Indeed, a framework that incorporates these principles and enables organisations to plan and manage the collection of performance data and analysis (including reporting and reviewing) will be an invaluable contribution to the effectiveness of the performance monitoring system by ensuring that comparable data will be collected on a regular and timely basis.

An integral component of this research is the development of a monitoring and evaluation framework (MEF) that incorporates current international best practice in EfSD framework development (i.e. UNESCO, Monitoring and Evaluation Expert Group) and extends the current benchmarks to align with the goals and targets of decentralised, global networks. The

emerging theoretical framework herein is based on a review of existing literature and best practice examples of monitoring and evaluation frameworks in Australia and worldwide. In addition, it stems from document analysis and key informant interviews conducted as a component of research undertaken in February to May 2012. This framework is consistent with the objectives identified in the Global Monitoring and Evaluation Framework Operational Plan (UNESCO, 2007) and builds upon the work undertaken by the Monitoring and Evaluation Expert Group (Tilbury, 2009). Aligning with accepted industry principles and practices (USAID, 1996; Stem, 2005), the methodology for this project has been developed in part through an internal consultation process with key actors (e.g. Environment and Schools Initiative), and is further based on a ‘quadruple bottom line’ approach to scalability.

**Figure 1. Monitoring and Evaluation Theoretical Framework**

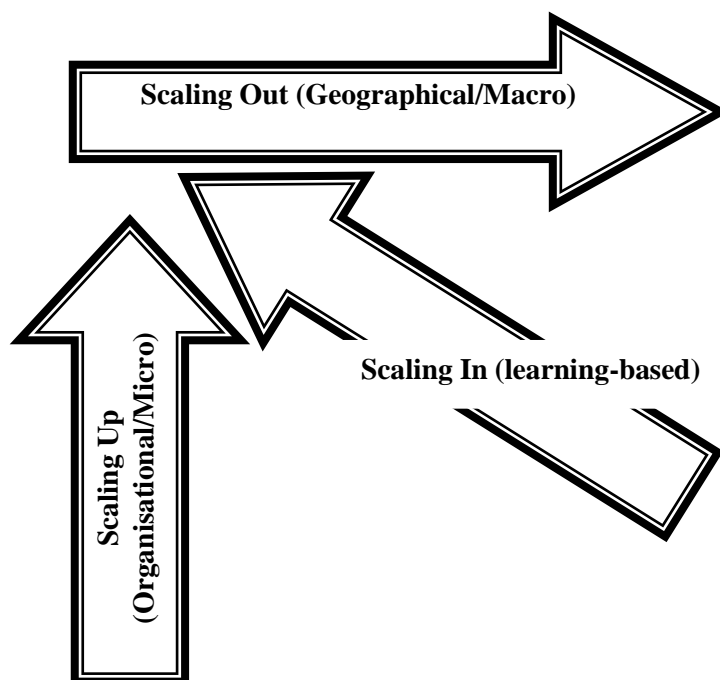


The purpose of the Framework is to establish a clear direction for decentralised organisations whilst assisting the organisation’s management team as they develop specific project plans and associated objectives. The Framework integrates the vision articulated by the organisation into a clear organisational, or project specific, direction and methodology. In addition it is envisioned that the organisation will use this document to inform project-related decisions improving success rates through resilient and innovative organisational management and project development. This Framework builds the foundation for Organisational Management Reporting (Azapagic, 2003), with the approach and recommendations being used to inform the Management Systems integral to operating as a facilitator of education for sustainable development. Embedded within this tool is a set of ‘performance indicators’ which provides the means for measuring organisational and project success rates.

### **Nested Frameworks**

An important foundation for the theoretical frame being developed is a monitoring and evaluation approach that engages with multiple dimensions (scales) of a complex framework of interrelated aggregate and sub-indicators. Figure 2 provides a visual representation of a multi-scale, nested framework developed as a key theoretical component of this research.

**Figure 2: Multi-scale, Nested Framework**



The key dimensions of this nested framework include:

1. Scaling out (horizontal) – geographical reach from local to a global scale;
2. Scaling up (vertical) – institutional development and project/organisational development; and,
3. Scaling in (depth) – learning based through ethics and values-based development and discourse analysis.

It is noteworthy to emphasise that the goals, targets, and subsequent indicators which the Framework comprises are context specific and generated in consultation with specific organisations to ensure their effectiveness. Accurate weightings are given to elements of the framework that provide foundations for innovation in organisational management. This will require further consultation between the researcher and the core case study to generate and substantiate outcomes; thereby, ensuring sustainability objectives are relevant and achievable. This process will help to ensure that resilience is integrated into organisational management and project delivery.

### **Organisational Implications**

Decentralised organisations ‘perform the kinds of functions typically identified with government—helping the disadvantaged, providing social services, supporting collective services such as museums and schools, preserving the environment, funding medical research, and the like. It is important to keep in mind that ‘when government provides these services in forms and amounts that voters want, there will be little role for nonprofits’ (Weisbrod, 1997:542). This observation presents one of the most significant barriers and opportunities to

the growth and success of non-profits. They have the opportunity to fill gaps that are left open by government and private organisations. However, conversely, they are continuously under pressure to reinvent their offerings and justify their accomplishments in order to maintain currency, and often, funding. Nonprofits are, thus, understandable as an alternative and often successful mechanism for providing collective services (Weisbrod, 1997:542). For example, Weisbrod (1997) predicts that the increased fiscal pressure on nonprofits will lead them to generate new, more creative forms of commercial activities, and that these new forms will further blur the distinctions between non-profit organisations and private firms. Emerging avenues for competition and cooperation with the private sector, government, consumers and other non-profits themselves can present some significant challenges for non-profit organisations facilitating and attempting to scale up EfSD projects.

Decentralised organisation's must surmount a myriad of barriers and opportunities within both organisational and project/program specific contexts. A phenomenon that prevents organisations entering or serving a market in a viable way is defined by Oster (1995) as a 'barrier' in the non-profit sector. Organisations are continuously faced with barriers some of which include (Oster, 1995):

- National and/or International reputation;
- Access to market and/or distribution channels;
- Economies of scale;
- Government regulation and controls; and,
- Costs of failure and high mortality rates of non-profits

An area of further challenge is that of endeavoring to recreate the 'one-size fits all' model. Attempting, for example, to scale educational innovations without realising that their effectiveness is often eroded by variations in implementation context may result in a 'replica trap'; repeating everywhere what worked locally without taking into account individual variations in needs and assets (Wiske & Perkins, 2005). Non-profits must be aware of this tendency and prepared to monitor the scaling process to ensure that projects do not experience diminished outcomes as a result of project expansion. For example, in the case of ICTs, in an attempt to rise up to the challenges presented it is important that innovations are brought to scale primarily in two complementary ways: automation and individualisation. Automation simplifies and standardises a product or service so that necessary tasks to supply it require only pre-set routine actions by people or machines. Individualisation produces variants of products tailored to a wide spectrum of styles and tastes. Applied automation achieves scale via the lowest common denominator, the one-size-fits all design and implementation strategies. Individualisation achieves scale by meeting a spectrum of customer needs with a customisable product or service – often at some cost in terms of price, complexity of co-design, and challenges in usage compared to alternative products or services mass-produced through automation (Clark, et al., 2006). Barriers and opportunities to facilitating EfSD are interwoven into many contrasting approaches to scalability and EfSD delivery. The challenge for decentralised organisations is in identifying these barriers and opportunities early on in the process or as they materialise. This early identification will assist in ensuring that a strategy is in place to mitigate and/or adapt to challenges.

## Conclusion

It is becoming evident in the EfSD literature that economic and governance attributes of EfSD facilitation are the least reviewed, with a significant amount of interest shown in environmental and social aspects of EfSD (e.g. Tilbury, 2005, 2007, and 2009; Bartelmus, 2008, 1997). It is therefore vital that future research, and the theoretical framework identified in this research, include economic and governance indicators, within a whole of system

monitoring and evaluation framework, to guide the feasibility and outcomes of EfSD programs and the organisations that deliver them. Further research will continue to examine decentralised global networks (e.g. NPO, NGO, and INPA) and their facilitation of EfSD through a macro and micro case study lens, ensuring that the theoretical and monitoring and evaluation frameworks provide robust academic utility and significance. The investigation of the ‘systems’ in which global networks must operate and how these political, social, economic and environmental systems interact is an integral part of the theoretical grounding of this research. Educational systems, as identified by the United Nations Statistical Institute for Asia and the Pacific (SAIP, 2007), can be viewed as a form of ‘production’ which has three components i) inputs; ii) processes; and, iii) outputs (and outcomes). Funding mechanisms are weighted heavily in favour of measured outputs which demonstrate that the processes used to facilitate EfSD are sound and can justify what is often a significant input, both financially and symbolically.

The challenges, and more specifically economic barriers, which organisations face, are rapidly expanding as global economies tighten up and face fiscal trials that put pressure upon the funding mechanisms that often provide organisational continuity. Above anything else, justification for funding is increasingly becoming a key driver and measure of organisational resilience. Incorporate the increasingly global playing field of organisations and funding mechanisms/sources, and one discovers that facilitators of EfSD are progressively faced with a competitive marketplace in which to ply their trade. Decentralised, global networks integrating and espousing modern mediums of learning (e.g. ICT) may embrace an opportunity to increase both scale and leverage through systemic delivery of EfSD programs with, for example, a decreasing requirement for capital. These barriers and opportunities and associate management and delivery issues will continue to be investigated throughout the course of further research.

## References

- Anheier, H. (2000). Managing Non-Profit Organisations: Towards a new approach. *Civil Society Working Paper 1. Centre for Civil Society, London, United Kingdom.*
- Azapagic, A. (2003). Systems Approach to Corporate Sustainability: A general management framework. *Institution of Chemical Engineers, Vol. 81.*
- Bandura, A. (1977). *Social Learning Theory*. Stanford University, Prentice Hall.
- Bartelmus, P. (2008). Indicators of Sustainable Development. *The Encyclopedia of Earth.* [http://www.eoearth.org/article/Indicators\\_of\\_sustainable\\_development](http://www.eoearth.org/article/Indicators_of_sustainable_development)
- Bartelmus, P. (1997). *Measuring sustainability: data linkage and integration*, in: Moldan, B., S. Billharz and R. Matravers, Sustainability Indicators: A Report on Indicators of Sustainable Development, Chichester and others: Wiley.
- Bellamy, J., Smith, T., Taylor, B, and Walker, M, (2005). *Regional natural resource management planning arrangements: evaluating through the regional lens*, in Bellamy, J. (Ed). Regional natural resource management planning: the challenges of evaluation as seen through different lenses. CIRM Occasional Paper, The State of Queensland (Department of Natural Resources and Mines).
- Blake, J. (1999) Overcoming the ‘value–action gap’ in environmental policy: tensions between national policy and local experience, *Local Environment*, 4(3), pp. 257–278.

- Bouwen, R. and Taillieu, T. (2004). Multi-party collaboration as social learning for interdependence: developing relational knowing for sustainable natural resource management. *Journal of Community and Applied Social Psychology*, vol. 14, pp. 137-153.
- Catacutan, D.C. (2005). Research on Scaling Up. Enabling Participatory Research and Development. *Participatory Research and Development for Sustainable Agriculture and Natural Resource Management: A Sourcebook Vol 1-3*.
- Chahine, S. and Tannir, L. (2010). *The Social and Financial Effects of the Transformation of Microfinance NGOs*. The Suliman Olayan School of Business, American University of Beirut, Lebanon.
- Clark, J., Dede, C., Jass Ketelhut, D., and Nelson, B. (2006). A Design-based research strategy to promote scalability for educational innovations. Harvard Graduate School of Education and Arizona State University.
- Cogburn, D.L. (1998). *Globalisation, knowledge, education and training in the information age*. Centre for Information Society Development in Africa and Global Information Infrastructure Commission, South Africa.
- Committee Consultative Group on International Agricultural Research. (1999). Scaling Up Sustainable Agriculture Initiatives. *Highlights and Synthesis of Proceedings of the CGIAR NGO Committee Workshop*. World Bank, Washington, D.C., USA, October 22-23.
- Conroy, D.K. (2005). Non-profit organisation and accountability: A comment on Mulgan and Sinclair Frameworks. *Third Sector Review*, 11(1).
- Dede, C., Honan, J., & Peters, L., Eds. (2005). *Scaling Up Success: Lessons Learned from Technology-Based Educational Innovation*. New York: Jossey-Bass.
- Department of Environment, Water, Heritage and the Arts. (2009). *Living Sustainably: The Australian Governments National Action Plan for Education for Sustainability*. DEWHA, Environment Standards Branch, Canberra, ACT.
- Department of Environment, Water, Heritage and the Arts. (1997). *Teaching for a Sustainable World: International Edition*. Griffith University, Centre for Innovation and Research in Environmental Education.
- Department of Environment and Heritage. (2005). *Educating for a Sustainable Future: A national environmental education statement for Australian schools*. Curriculum Corporation, Victoria.
- Doh, J., & Teegen, H. (2003). *Globalization and NGOs: Transforming business, government and society*. Westport: Praeger.
- Eder, D.J. (2004). General Assessment within the Disciplines. *The Journal of General Education*. 53(2): 135-157.
- Ellis, T.J. and Levy, Y. (2008). Framework of problem-based research: A Guide for Novice Researchers on the Development of a Research. *Worthy Problem*. Vol.11, pp. 17-33.

- Gibson, C.M. (2006). *Citizens at the Centre: A new approach to civic engagement*. The Case Foundation.
- Global Information Infrastructure Council (GIIC) Forum. (1998). *Rethinking Education and Training to Meet the Challenges of the 21<sup>st</sup> Century*. Global Information Infrastructure Commission, Washington, D.C., p. 4.
- Greenberg, M. T., Domitrovich, C., Graczyk, P. A., & Zins, J. E. (2002). The study of implementation in school-based prevention research: Implications for theory, research, and practice. *Report submitted to The Center for Mental Health Services. Rockville, MD: Substance Abuse and Mental Health Services Administration*.
- Hallak, J. (1998). Education and Globalisation. International Institute of Educational Planning. *Presentation given at the IIEP on 5 March, 1998*.
- Heskett, J. (2002) *Toothpicks and Logos: Design in Everyday Life*. Oxford University Press, USA, p 1.
- Hill, D. (2005). Globalisation and Its Educational Discontents: neoliberalisation and its impacts on education workers' rights, pay and conditions. *International Studies in Sociology of Education, Volume 15, Number 3*.
- Kenney, R. and Florida, M. (1993). *Beyond Mass Production: The Japanese System and Its Transfer to the United States*. Oxford University Press, New York.
- Klauer, B., Drechsler, M. and Messner, F. (2006). Multicriteria analysis under uncertainty with IANUS-method and empirical results. *Environment and Planning C: Government and Policy, Vol. 24, pp. 235-256*.
- Knight, J. & de Wit, H. (1997). *Internationalisation of HE in Asia Pacific countries*. European Association for International Education, Amsterdam.
- Kollmuss, A. and Agyeman, J. (2002). Mind the Gap: why do people act environmentally and what are the barriers to pro-environmental behaviour. *Environmental Education Research, Vol. 8(3)*.
- Krishna, S. (2008). *Globalization and Postcolonialism: Hegemony and Resistance in the Twenty-first Century*. Lanham: Rowman Littlefield Publishers.
- Laurance, W.F., M.A. Cochrane, S. Bergen, P.M. Fearnside, P. Delamônica, C. Barber, S. D'Angelo and T. Fernandes. (2001). The Future of the Brazilian Amazon. *Science* 291: 438-439.
- London School of Economics and Political Science Centre for Civil Society. (2006). 'What is Civil Society? [www.lse.ac.uk/collections/CCS/what\\_is\\_civil\\_society.htm](http://www.lse.ac.uk/collections/CCS/what_is_civil_society.htm) - last accessed on 8, May 2012.
- Margoluis, R., and N. Salafsky. 1998. *Measures of success: designing, managing, and monitoring conservation and development projects*. Island Press, Washington, D.C.
- McGrew, A. (2007). *Globalization in Hard Times: Contention in the Academy and Beyond*. In G. Ritzer (Ed.), *The Blackwell Companion to Globalization*. Malden, MA.: Blackwell Publishing.



- McKinney, J. B. (2004). *Effective Financial Management in Public and Non-Profit Agencies*. Praeger Publishers, Westport, CT.
- Mehta, S. & Kalra, M. (2006), 'Information and Communication Technologies: A bridge for social equity and sustainable development in India', *The International Information & Library Review* 38(3), 147-160.
- Meyer, J. W. (2007). Globalization: Theory and Trends. *International Journal of Comparative Sociology*, 48(4), 261-273.
- Milbrath, L.W. (1989). *Envisioning a sustainable society: Learning our way out*. State University of New York Press, Albany.
- Orr, D. (1992) *Ecological Literacy: education and the transition to a postmodern world*. Albany, State University of New York Press.
- Oster, S.M., (1995). *Strategic Management for Nonprofit Organizations: Theory and Cases*. Oxford University Press, New York.
- Parish, B.D. (2007). *Designing the sustainable enterprise*. Sustainability Research Institute, School of Earth and Environment, University of Leeds, Leeds.
- Pink, D.H. (2006) *A Whole New Mind: moving from the Information Age to the Conceptual Age*. Penguin Group, USA.
- Roberts, S.M., Jones III, J. P., and Frohling, O. (2005). NGOs and the Globalization of Managerialism: A Research Framework. *World Development*, Vol 33(11), pp.1845-1864.
- Sachs, W. (2000). *Globalization and Sustainability*. Unpublished manuscript, Berlin, Germany.
- Sachs, J.D. and McArthur, J.W. (2005). *The Millennium Project: A plan for meeting the Millennium Development Goals*. Published online, The UN Millennium Project, New York.
- Stem, C., Margoluis, R., Salafsky, N., and Brown, M. (2005). Monitoring and Evaluation in Conservation: A Review of Trends and Approaches. *Conservation Biology*, Vol. 19, No. 2.
- Sterling, S. (2003). *Whole Systems Thinking as a Basis for Paradigm Change in Education – explorations in the context of sustainability*. Doctoral Thesis. Centre for Research in Education and the Environment. University of Bath, U.K.
- Tàbara, J. D., and C. Pahl-Wostl. (2007). Sustainability learning in natural resource use and management. *Ecology and Society* 12(2): 3.
- Tilbury, D. (2009). Tracking Our Progress: A Global Monitoring and Evaluation Framework for the UN DESD. *Journal of Education for Sustainable Development* 2009; 3; 189
- Tilbury, D. (2007). Monitoring and Evaluation during the UN Decade of Education for Sustainable Development. *Journal of Education for Sustainable Development*, 1:2, 239-254.

- Tilbury, D. et al. (2007). *Monitoring and assessing progress during the UNDESD in the Asia-Pacific Region: A quick guide to developing national ESD indicators*. Bangkok, UNESCO Bangkok.
- Tilbury, D., and Janousek, S. (2006) Development of a National Approach to Monitoring, Assessment and Reporting on the Decade of Education for Sustainable Development: Summarising Documented Experiences on the Development of ESD Indicators and Networking with Expert Groups on ESD Indicators. *Sydney: Australian Research Institute of Education for Sustainability and Australian Government Department of the Environment and Water Resources*.
- UNESCO, Institute for Statistics. (2002). Financing Education: Investments and Returns – Analysis of the World Education Indicators. *Organisation for Economic Co-Operation and Development, World Education Indicators Programme*.
- United Nations, Department of Economic and Social Affairs. (2003). Citizens, Businesses and Governments: Dialogue and Partnerships for Development and Democracy. *Fourth Global Forum on Reinventing Government. Capacity Development Workshops, Morocco*.
- United Nations Statistical Institute for Asia and the Pacific. (2007). *Country Training Workshops on MDGs and Use of Administrative Data Systems for Statistical Purposes*. RETA6356: Improving Administrative Data Sources for the Monitoring of MDGs.
- USAID Centre for Development Information and Evaluation. (1996). 'Performance Evaluation and Monitoring – Preparing a performance monitoring plan'. *Centre for Development Information and Evaluation. Issue 7*.
- Uvin, P., Jain, P.S., and Brown, L.D. (2000). Think Large and Act Small: Toward a New Paradigm for NGO Scaling Up. *World Development*, Vol. 28(8), pp. 1409-1419.
- Uvin, P. (1995). Fighting hunger at the grassroots: Paths to scaling up. *World Development*, Vol. 23(6), pp. 927-939.
- Van Peborgh, E. (2008). *Sustainability 2.0 Networking Enterprises and Citizens to Face World Challenges*. Odiseo, Buenos Aires, Argentina.
- Weisbrod, B.A. (1997). The future of the nonprofit sector: It's entwining with private enterprise and government. *Journal of Policy Analysis and Management*, Vol. 16(4), pp. 541-555.
- Wiske, M.S., & Perkins, D. (2005). *Dewey goes digital: Scaling up constructivist pedagogies and the promise of new technologies*. In C. Dede, J. Honan, & L. Peters, Eds, *Scaling up success: Lessons learned from technology-based educational innovation*. New York: Jossey-Bass.
- Woodhill, J. (2000). Planning, monitoring and evaluating programmes and projects: introduction to key concepts, approaches and terms. *World Conservation Union, Gland, Switzerland*.

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# **Proceedings of the 18<sup>th</sup> Annual International Sustainable Development Research Conference, University of Hull, Hull, UK, 24 – 26 June 2012; Track 3a**

## **Strengthening the institutional frameworks for risk management and sustainability in trans-boundary ecosystems and environment in Asia**

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Despite that robust economy growth continue to lift pressures on the environment, institutional mechanisms in Asia remains enfeebled for safeguarding the environment and sustainability. Asia needs to facilitate institutionalization for ensuring (i) access to environmental information, (ii) participation in decision-making and (iii) access to judicial proceedings. The paper reviews positive steps taken, for instance, by the Mekong River Commission that adopted and implement the Guidelines on Implementation of the Procedures for Notification, Prior Consultation and Agreement with the view to facilitation public access to information and stakeholder engagement. The Coral Triangle Center of Southeast Asia ostensibly follow suit. The paper develop discussions that such progressive practices will forge collaborations among countries in Asia and prompt the creation of the region-wide mechanisms that would allow countries in the region to commence a peer review of environmental policies and allow individual petitions for more effective and democratic environmental management at the transnational/regional level in Asia.

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## 1. Introduction

Asia continues to undergo robust economic development and increasingly intensive resource use. Transnational and interdependent resource use inevitably entails a concern over excessive resource depletion and pollution that generate negative impacts across borders. Asian countries have multiple forums to address such environment and natural resource issues at the regional levels. However, the modalities of multilateral frameworks for governing trans-boundary environment and natural resource management vary significantly in terms of the institutional set-up, memberships, mandates, functions and financial mechanisms. The effectiveness of transboundary environment and natural resource management may not necessarily exclusively attribute at the rectitude in such institutional frameworks. In the process of exploring measures to strengthen institutional frameworks for sustainable development in conjunction with the 2012 Rio + 20 Summit, it is deemed as vital to examine the effectiveness of transboundary environment and natural resource management in Asia. This paper is intended to highlight the key features of some transboundary environmental and natural resource management mechanisms in Asia, and to present perspectives for exploring policy options to strengthen transboundary environment and natural resource management in Asia.

## 2. Leading transboundary environment and natural resource management mechanisms in Asia

### (i) EANET for monitoring acid rain deposition

When the level of acid rain was alarmed in 1980s - 90's in Europe and Asia, Asian countries started exploring measures to monitor acid rain deposition across Asia. In April 1998, the so called "EANET", an Asia regional network for monitoring acid rain deposition was launched as a pilot phase, and it has started its full-fledged operation in January 2001. EANET is supported by 14 technical institutions that are located in 13 Asian countries. The data has been consolidated and information is disclosed to the public. The EANET operational budget is covered by the scheme that follows the United Nations scale of assessment with which countries share the budget primarily in proportion with the respective GDP. No significant acid rain deposition increase has been inspected over the years. At the same time, there is limited evidence that shows that the outcome of data analysis is used for a regional policy dialogue to influence the policies, for instance on air pollution, energy or climate change at the regional level.

### (ii) NOWPAP

The Northwest Pacific Action Plan (NOWPAP) and the Northwest Pacific Region Environmental Cooperation Center are other major and long-standing regional environmental mechanism that operates in Asia. NOWPAP is one of the regional sea programmes developed under the auspices of the United Nations Environment Programme (UNEP). NOWPAP was adopted in September 1994 by Japan, China, Republic of Korea and Russia in Seoul. Under NOWPAP, it was decided to distribute

thematic issues across the member countries and establish or designate a technical institution in respective countries. In the case of Japan, The Special Monitoring & Coastal Environmental Assessment Regional Activity Centre (CEARAC) was established in April 1999 in Toyama, Japan and it monitors marine environment conditions.

NOWPAP is considered as a significant mechanism as it unites 4 major countries to cooperate in monitoring marine environmental conditions without having major political interference. It provides credible scientific data and support information exchange and human resource development. The operating cost is also shared in accordance with the UN scale of assessment equivalent. Marine environmental protection is raised in the Three Environment Ministers' Meeting that take place every year as a forum for the governments of China, Japan and the Republic of Korea to discuss common environmental issues. The North-East Asian Subregional Programme for Environmental Cooperation (NEASPEC) is another forum to provide a dialogue platform for an extended Northeast Asian country mechanism including the aforementioned three countries plus the Democratic People's Republic of Korea (DPRK), Mongolia and the Russian Federation. Yet, there is still little evidence to show that there has been a significant interaction between monitoring data analysis and regional policy transformation in terms of managing and improving the international sea in Northeast Asia.

(iii) Other transboundary environment and natural resource management mechanisms

Dust and sand storms are a one of the trans-boundary environmental problems that ostensibly originate in China and Mongolia and affect not only these originating countries, but also other neighbouring countries such as the Republic of Korea and Japan. The volume of floating sand particle affects optimal and respiratory conditions of human health and hinders air travels and precision industry production. A project for tackling sand and dust storms in Northeast Asia was developed and funding was made available by the Global Environment Facility and the Asian Development Bank. The project was said to be worth US\$13.8 million to help combat land degradation in six provinces and autonomous regions of China's western region (Environmental News Service 2004). It was the first step in a \$1.5 billion, 10 year program to 2012 under a GEF-China Partnership on land degradation in dryland ecosystems. Bilateral assistance was also provided by the Japanese Government through the Japan International Cooperation Agency (JICA). In the project entitled "Development of Human Capacity for Weather Forecasting and Data Analysis" worth JPY501 million for the duration of 2005 – 2008, JICA supported human resource development and institutional building for dust and sand storm monitoring particularly by the Mongolian National Agency for Meteorology, Hydrology and Environment Monitoring as well as the Ministry of Nature and Environment (JICA 2010 b).

In respective countries, there were groups that have been reviewing the project implementation. However, it was not clear whether collaboration that emerged for supporting the project has led to the formation of trans-national policy coordination and enabling mechanisms.

The Coral Triangle Initiative is a trans-boundary mechanism to support coral reefs' protection among the countries in Southeast Asia. Marine water areas and coasts in Indonesia, Malaysia, Papua New Guinea, the Philippines, Solomon Islands and Timor-Leste are rich in coral reef and marine biodiversity. The area is called the "Coral Triangle" that covers almost 1.6 billion acres equivalent to the half the size of the United States (WWF). The area is home to 3,000 species of fish and sustains over 120 million people and garners more than \$12 billion a year from nature-based tourism. This abundant marine life is, however, at risk due to unsustainable fishing, poorly planned development, pollution, a growing population and the effects of climate change

In order to safeguard the marine and coastal resources in the region, Indonesian President Yudhoyono took a lead with other leaders to launch the Coral Triangle Initiative on Coral Reefs, Fisheries and Food Security (CTI-CFF) in 2007. The CTI-CFF is a multilateral partnership between the governments of Indonesia, Malaysia, Papua New Guinea, Philippines, Solomon Islands and Timor-Leste (Coral Triangle Initiative).

The Global Environment Facility (GEF) provides funds to the Coral Triangle Initiative. In April 2008, a program was endorsed that was worth \$63 million to cover biodiversity, international waters, and adaptation to climate change. The program was aimed to catalyze more than \$300 million of co-financing for the Initiative to conserve tuna and coral ecosystems while alleviating poverty (GEF).

The planning of the GEF CTI program was led by the countries and it was accompanied by the Asian Development Bank, the coordinating agency, and four other GEF agencies: FAO, UNDP, UNEP and the World Bank. A year later, the 76% (\$45.5 million) of the funds have already been allocated for the implementation of nine projects in the six participating countries. The following are some of the projects that are currently under implementation or that are about to start:

The Asian Development Bank (ADB) has been developing a programme entitled "the Coral Triangle Initiative/Coral Reef Rehabilitation Program" for approval in 2013 and it is worth USD 500,000 as ADB co-financing.

The Coral Triangle Center (CTC) has been playing a pivotal role in supporting the activities to conserve marine environment in the Coral Triangle. CTC began in 2000 as a program of The Nature Conservancy and in late 2010, CTC was established as an independent regional Foundation registered in Indonesia (Coral Triangle Center).

The Coral Triangle Initiative, spearheaded by the Government of Indonesia in collaboration with 5 other countries in the region has evolved as a sub-regional transboundary environmental programme with an independent secretariat set-up and multi-donor financial support. The transformation of policies and institutional and human resource development are being promoted under the initiative, and their impacts still need to be observed.

Sustainable Forest and Biodiversity Management in Borneo is a project that aims forests and biodiversity conservation in Borneo involving Indonesia and Papua New Guinea. In June 2007, the GEF-4 Sustainable Forest Management Program was created, better known as the Tropical Forest Account (TFA). The TFA reserved funds from the Biodiversity, Climate Change, and Land Degradation in the three major tropical forest blocks namely Amazonia, Congo Basin, and New Guinea/Borneo. According to the report released in 2010, GEF has allocated \$250 million for its Sustainable Forest Programme which was aimed to leverage an additional \$750 million to generate a transformative impact on forest biodiversity (GEF 2010 b). The Asian Development Bank approved in 31 August 2012 the project entitled "Sustainable Forest and Biodiversity Management in Borneo" with the support of US\$700,000 from its Regional Cooperation and Integration Fund and US\$1.25 million from its Climate Change Fund (31 Aug 2012 (ADB). Forest and biodiversity conservation in Borneo and Papua involving Indonesia and Papua New Guinea have provided a perspective for promoting collaborative actions by the two countries for pursuing the common objectives. Its impacts, however, yet need to be further examined.

There are some other mechanisms and forums that can be cited as trans-boundary environmental management to the extent they address transboundary nature of the environmental issues concerned. However, the weight of such mechanism is more placed on the national policy development and implementation for managing national or local environment. Thus, this paper does not necessarily examine such mechanisms in details.

In the following sections, the paper address the major case studies on transboundary-environmental management that demonstrate some lessons and future perspectives for the institutional development aimed at transboundary environmental management and sustainable development in the areas and countries concerned.

### 3. ASEAN Haze Agreement

#### (i) ASEAN Haze Agreement development



In 1980's, haze was frequently covering sky in Southeast Asian countries and obstructing sun light and raised a concern over human health and air transport. It was believed that haze emanate from the areas in Indonesia where local people were ostensibly engaged with deforestation, slash and burn and forest fires for excessive logging and timber export as well as forest clearance for farm land reclamation.

ASEAN countries started consultation to mitigate and prevent haze phenomena in Southeast Asia. In 2001, ASEAN countries started negotiation to develop a legally binding instrument to resolve haze problems with the assistance of UNEP and the Hanns Seidel Foundation. In June 2002, the negotiation was concluded and the agreement was adopted. ASEAN countries have ratified the ASEAN Haze Agreement that was seen as an epoch-making policy instrument in a sense that it is a transnational legally binding instrument to deal with transboundary environment among Asian countries.

The Haze Agreement provides a legal basis for the ongoing activities of the Regional Haze Action Plan (RHAP) to deal with haze arising from land and forest fires in the region. Such activities include timely and more accurate weather forecast and early warning measures, strict enforcement of existing laws and enactment of new laws to regulate open burning, training of prosecution and law enforcement officers, development of preventive tools such as GIS database and fire danger rating systems, information management through the ASEAN Haze Action On-line website, and mitigation efforts in member countries.

The Agreement obligates member countries to (1) co-operate in developing and implementing measures to prevent, monitor, and mitigate transboundary haze pollution by controlling sources of land and/or forest fires, establishment of early warning systems, exchange of information and technology, and the provision of mutual assistance; (2) respond promptly to a request for relevant information sought by a state or states that are or may be affected by such transboundary haze pollution when the transboundary haze pollution originates from within their territories; and (3) take legal, administrative and/ or other measures to implement their obligations under the Agreement.

The Haze Agreement provides for the establishment of an Asean Coordinating Centre for Transboundary Haze Pollution Control to facilitate cooperation and coordination in managing the impact of land and forest fires, in particular haze pollution arising from such fires.

There was and has been a blur with this ASEAN Haze Agreement. Indonesia that participated in the negotiation hasn't yet become a party to the Agreement. The Indonesian Parliament rejected the ratification of the Haze Agreement on the ground that the Haze Agreement did not have provisions on the control of illegal timber trade (Jakarta Post 2011 a). The Government of Indonesia continues to assert at the ASEAN Haze Agreement Conference of the Parties that Indonesia intensifies its effort to accede to the Agreement though it hasn't yet become a party to the Agreement.

The Indonesia's position vis-à-vis the ASEAN Haze Agreement deserves assessment from holistic viewpoints. The Indonesia's non-party/observer status in the ASEAN Haze Agreement can be still seen as an obstacle to promote more efficient and enhanced collaboration among ASEAN countries to tackle forest fires in Southeast Asia particularly in Indonesia. At the same time, Indonesia has started taking more progressive policy approaches to promote sustainable forest management in the context of carbon management and climate change mitigation.

(ii) Indonesia's voluntary GHG emission reduction targets  
Costa Rica and Papua New Guinea have proposed measures for reducing green house gases emissions in tropical forests in developing countries. The concept has evolved as Reducing Emissions from Deforestation and Degradation or REDD and the Bali Action Plan was adopted at the 13<sup>th</sup> Session of the Conference of the Parties to the United Nations Framework Convention on Climate Change (UNFCCC) held in Bali, Indonesia in December 2007. Subsequently, President Susilo Bambang Yudhoyono has announced at the G20 Pittsburgh Summit in 2009 that Indonesia would reduce its GHG emissions by 26 per cent by 2020 and by 41 per cent with international assistance. President Yuhdoyono signed a presidential decree creating a National Action Plan to Reduce Greenhouse Gas Emissions although the level of its implementation carries more importance and needs to be seen in coming years.

The announcement of the Indonesia's voluntary GHGs emission reduction targets has created favourable conditions for Indonesia to receive assistance from bilateral donor countries and international financial institutions. Japan, Norway, France and the World Bank have provided financial assistance to Indonesia either as general fiscal support under the pretext of supporting Indonesia in implementing its positive policies towards mitigating climate change or providing financial assistance directly to support the strengthening of human resources and institutional capacity for monitoring forestry and supporting sustainable forest management.

JICA has concluded a second loan agreement with Indonesia on 23 June 2010 worth JPY27.2 billion or US\$300million following the first loan of US\$300milli agreed in August 2008. The loan was said to be provided based on the assessment of the policy implementation level with respect to (a) the development of the proposed Presidential Decree for reducing GHGs emissions by 26 per cent by 2020, mobilisation of financial resources for climate change countermeasures, the development of indicators for measurement/reporting/verification, (b) mitigation through forest conservation and management, peat land conservation, renewable energy development, energy efficiency promotion, (c) adaptation through weather forecasting model improvement and integrated water resource management.

Norway provides financial assistance in a performance based approach. Funding will be disbursed based on the assessment of the policy implementation level by the Government of Indonesia more specifically in the context of "REDD +" that promotes not only the reduction of GHG emissions from deforestation and forest degradation, but also forest conservation, sustainable forest management and carbon sink expansion. Indonesia claims that 1.5 billion tons of CO<sub>2</sub>e is equivalent to 1.13 million ha deforestation and that deforestation in Indonesia decreased to 832,000ha in 2009 and the reduction of 293,000ha deforestation is equivalent to 193million tons of CO<sub>2</sub>e. Norway has concluded agreements with the Government of Indonesia that Norway provides specific amounts of funds for a series of activities to support REDD+ including institutional development, monitoring and evaluation framework development and implementation, national communication and empowerment programme, safeguard mechanisms development, MRV framework development, pilot project development and plans for suspension of forest conversion concession worth in total US\$28 million.

Indonesia succeeded in demonstrating positive and visible policy development and institutional transformation for promoting effective climate change mitigation and REDD+ policies. Climate change policies were used to be coordinated through the Ministry of Environment until 2007. Thereafter, Indonesia has established the National Council on Climate Change with the Presidential decree of 46/2008 and conferred authority on the Ministry of Forestry regarding the overall coordination for REDD+ (Ardiansyah, F. 2009). There was an argument asserted around this time that the opportunity cost of the Indonesia's forests could be more valuable than the value of the carbon stocks as palm oil price was rising around 2009. The Indonesia's stout REDD+ policies coupled with the strong political leadership and visible institutional transformation generated conditions conducive to mobilising substantive funds from donor countries and agencies.

(iii) Assessment on the Indonesia's approach to haze control and forest management The ASEAN Haze Agreement once considered as epoch making was tainted due to the absence of Indonesia as a full-fledged party to the Agreement. It could be concluded that an attempt to develop an international mechanism for transboundary environmental management failed to some extent although the Agreement remains valid and its Conference of the Parties continue to operate up to now. On the other hand, it is difficult to single out a key factor that induced Indonesia to take a lead in adopting a substantive voluntary GHGs emissions reduction target and facilitated policy and institutional transformation for climate change mitigation and REDD+ thereby one could expect that the common objectives of the ASEAN Haze Agreement could be achieved.

This case study reveals that the success of the movement for establishing a transboundary environmental management cannot be determined by the successful formation of the transnational/international regimes for transboundary environmental management. Even with the insufficient formation of the regime, the policy objectives envisioned in the first instance could be achieved in an alternative modality. Yet, in order to ensure the long term policy compliance and scaled up policy implementation, efforts need to continuously made towards enhancing rectitude in policy and institutional framework particularly by having critical members as full-fledged parties and installing effective policy mechanisms for policy performance review and compliance and enforcement assurance.

### 3. Mekong River Commission

The Mekong River is one of the world's great river systems. It flows 4,909 km through six countries: China, Myanmar, Thailand, Lao PDR, Cambodia, and Viet Nam. Local people of 60 million depend on the source of the river's great productivity and it is home to immense biodiversity (Mekong River Commission). Thus, it is critical to conserve ecosystems of the Mekong River and its basin.

To promote conservation of the Mekong River and its basin ecosystems, the United Nations has established the Mekong Committee dating back over 50 years. In 1995, the countries adopted the 1995 Mekong Agreement whereby the countries established the Mekong River Commission (MRC) as a coming-of-age for this river basin agency. Four Member Countries manages the operation of MRC namely; Cambodia, Lao PDR, Thailand and Viet Nam. China and Myanmar are not the full-fledged members of MRC. Instead, these two countries are engaged as MRC Dialogue Partners.

MRC operates with the support of a wide range of donor countries and agencies including major European countries and the international organisations such as Association of Southeast Asian Nations (ASEAN), United Nations Economic and Social Commission for Asia and the Pacific (UNESCAP), Asian Development Bank (ADB) World Bank, International Union for Conservation of Nature (IUCN) World Wide Fund for Nature (WWF) and United Nations Development Programme (UNDP).

Asian Development Bank is a leading funding agency for conservation and natural resource management in Mekong River and its basin. The project is entitled the "Greater Mekong Subregion (GMS)" covering 2.6 million square kilometers and a combined population of around 326 million (ADB). The project involves 6 countries namely, Cambodia, the People's Republic of China (PRC, specifically Yunnan Province and Guangxi Zhuang Autonomous Region), Lao People's Democratic Republic (Lao PDR), Myanmar, Thailand, and Viet Nam. Since 1992, the six countries commenced a program of subregional economic cooperation including transport, energy, telecommunications, environment, human resource development, tourism, trade, private sector investment, and agriculture (Asian Development Bank).

Substantial progress has been achieved since 1992. Infrastructure projects worth around US\$10 billion have either been completed or are being implemented. Among

these are the upgrading of the Phnom Penh (Cambodia)-Ho Chi Minh City (Viet Nam) highway and the East-West Economic Corridor that will eventually extend from the Andaman Sea to Da Nang. Natural resources provide both income and sustenance to the great majority of people in the subregion. To promote sustainable use of natural resources and embrace ecosystem services in the region, it is vital that the countries in the region collaborate under the framework of MRC and the Greater Mekong Sub-region project

One of the key policy instrument developed by MRK is the procedures for the prior informed consent. The Procedures for Notification, Prior Consultation and Agreement was approved by the MRC Council on 30 November 2003. Thereafter, the Guidelines on Implementation of the Procedures for Notification, Prior Consultation and Agreement was adopted at the MRC Joint Committee Meeting on 31 August 2005. The Guideline was instrumental as it provides specific provisions regarding the prior notification of the project proposal that affects the resource use of the Mekong River. This Guideline provides that the member countries must notify the inter-river basin project or the project that affect the River and its basin to the Mekong River Commission at least 6 months prior to the commencement of the project. The Mekong River Commission must review the submitted project proposal within 6 months after the submission.

There have been several cases that broke out as a source of conflicts between member countries. When Lao Government planed to construct the Don Sahong dam on the mainstream of the Mekong River in southern Laos in 2008, it raised a grave concern in Cambodia and internationally (IPS News). It was supposed to be the most advanced of eight hydropower projects mooted for the lower Mekong mainstream. The Don Sahong dam is also ramping up pressure on the Mekong River Commission (MRC), the inter-governmental body charged with managing development on the river.

On the other hand, the Myitsone dam project was planned in Myanmar with the China's investment, but the Government of Myanmar announced to halt the construction of the said dam despite that it would have been the first to span the Irrawaddy River, the largest waterway in Myanmar, and was a showcase project for the previous military government (New York Times). The halt in construction was a victory for dissidents in a country with a long history of stifling opposition.

It is ironical that the Don Sahong Dam project planned by Laos was reviewed by the prior informed consent procedures, but the plan was pressed by the Laos government despite the strong opposition by the Cambodian Government. On the other hand, the Myitsone Dame planned by Myanmar with the Chinese investment was reversed and withdrawn by the new Myanmar government due to the opposition by the local Myanmar people.

These cases reveals that the procedures like the prior informed consent will assure the stakeholders the proper information access and consultation opportunities, the optimal decision can be assured only by the proper policy decisions in respective countries.

#### 4. Conclusions and Recommendations

Asian countries need to facilitate mutual consultations and policy dialogues for forging transnational/regional/international mechanisms to promote transboundary environmental management. The basic framework of such mechanisms need to be structured to assure proper monitoring, information access, policy dialogue, policy review and other consultation procedures. Yet, the optimal decisions and effective engagement of stakeholders can be achieved only when the countries themselves have managed to establish the proper mechanisms for democratic and optimal decision making at the local and national level. Without such domestic/national mechanisms, there will be a limit in influencing transboundary environment and natural resource management. Thus, regional programme and international assistance must address the local and national stakeholders' awareness raising, access to information and decision making participation as an integral part of the transnational/regional/national collaborative activities aimed at effective transboundary environmental management.

Ardiansyah, F. 2009. Getting ready for REDD: Indonesia's case of policy and institutional framework of REDD. <http://www.asef.org/index.php> accessed on 18 May 2012

ASEAN. <http://www.aseansec.org/10202.htm> accessed on 16 May 2012

Asian Development Bank. Coral Triangle Initiative/Coral Reef Rehabilitation Program. <http://www2.adb.org/projects/project.asp?id=44329> accessed on 18 May 2012

Asian Development Bank. Sustainable Forest and Biodiversity Management in Borneo . <http://pid.adb.org/pid/TaView.htm?projNo=44413&seqNo=03&typeCd=2> accessed on 18 May 2012

Asian Development Bank. Greater Mekong Sub-region. <http://www.adb.org/countries/gms/main>

accessed on 18 May 2012

CEARAC. <http://cearac.nowpap.org/> accessed on 15 May 2012.

Coral Triangle Center. <http://www.coraltrianglecenter.org/> accessed on 17 May 2012.

Coral Triangle Initiative. <http://www.coraltriangleinitiative.org/> accessed on 18 May 2012

EANET. <http://www.eanet.cc/jpn/> accessed on 15 May 2012

Environment News Service. 29 June 2004. <http://www.ens-newswire.com/ens/jun2004/2004-06-29-06.html> accessed on 17 May 2012

Global Environment Facility. 2010. The GEF Incentive Mechanism for Forests A New REDD+.

Global Environment Facility. 2010 b. Financing the Stewardship of Global Biodiversity.

Global Environment Facility. <http://www.thegef.org/gef/CTI> accessed on 17 May 2012

IPS News. <http://www.ipsnews.net/2008/03/cambodia-planned-lao-dam-raises-concerns-on-the-mekong/> accessed on 19 May 2012

Jakarta Globe. 26 September 2011. <http://www.thejakartaglobe.com/nvironment/yudhoyono-signs-decree-to-reduce-greenhouse-gas-emissions/467797> accessed on 17 May 2012

Jakarta Post a. 22 January 2011. <http://www.thejakartapost.com/news/2011/01/22/govt-wants-haze-agreement-ratified.html> accessed on 16 May 2012.

Jakarta Post b. 31 October 2011. <http://www.thejakartapost.com/news/2011/10/31/plan-laid-out-indonesia-upbeat-about-its-2020-emission-target.html> accessed on 16 May 2012

JICA a. 23 June 2010. [http://www.jica.go.jp/press/2010/20100623\\_01.html](http://www.jica.go.jp/press/2010/20100623_01.html) accessed on 16 May 2012

JICA b. 13 July 2010. Project: Development of Human Capacity for Weather Forecasting and Data Analysis <http://gwwweb.jica.go.jp/km/ProjectView.nsf/b7daf2eabe456da849256bdf0038493d/1a5f937d3b5358e0492575d100356795?OpenDocument>

Mekong River Commission. <http://www.mrcmekong.org/> accessed on 19 May 2012

NEASPEC. <http://www.neaspec.org/> accessed on 16 May 2012

New York Times. <http://www.nytimes.com/2011/10/01/world/asia/myanmar-suspends-construction-of-controversial-dam.html> accessed on 18 May 2012

NOWPAP. [http://www.nowpap.org/main\\_j.php](http://www.nowpap.org/main_j.php) accessed on 15 May 2012

WWF. Coral Triangle. <http://www.worldwildlife.org/what/wherewework/coraltriangle/index.html> accessed on 17 May 2012



# **Proceedings of the 18<sup>th</sup> Annual International Sustainable Development Research Conference, University of Hull, Hull, UK, 24 – 26 June 2012; Track 3a**

## **Corporate Social Performance of Indian Public Sector Units on Strategic Governance and Stakeholder Dimensions Matrix**

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### **Abstract**

The paper is an attempt to find out the corporate social performance of Indian Public Sector Units. Two indicators have been identified to assess the corporate social performance of the companies, namely, Strategic Governance and Responsibility towards the Stakeholders. Content analysis of the annual reports of the Central Public Sector Enterprises (specifically, Maharatnas and Navratnas) has been undertaken. The paper, while establishing a relationship between Strategic Governance and Stakeholders responsibility, concludes with the average social performance of the Indian PSU's as assessed on the two dimensions.

### **Introduction**

The concept of social responsibility is embedded in the value systems of Indian corporate. Indian corporate has been indulging in philanthropic activities since their inception. The Government of India has made it mandatory for the Central Public Sector Undertakings (PSU's) to undertake Corporate Social Responsibility (CSR) activities and to essentially allot 2% - 5% of their net profits towards their social activities. The issue of making social responsibility mandatory for companies was an issue of contention as generally CSR is understood to be a voluntary activity. The Ministry of Corporate Affairs in association with the Indian Institute of Corporate Affairs

(IICA) has also given voluntary guidelines for the corporate to follow. These voluntary guidelines lay out principles to be followed by the corporate to take care of all areas of concern while undertaking CSR activities.

Following the Government guidelines, PSU's in India are taking care of their bit of social responsibilities. Some companies have also formed their foundations which undertake developmental activities in their nearby communities like building of schools, dispensaries, sports promotions etc. Heavy industry companies like Coal India, NTPC and others are taking care of the project affected people nearby the sites where they are operating.

In a system like that of India, where public sector should play as an idol for their private counterparts and where the Government has made it mandatory to undertake CSR activities for the public sector companies, the intent of this paper is to examine the social performance of public sector enterprises.

Firstly, the paper brings out the status of Indian PSU's with respect to their social performance. It also examines how genuine they are in their efforts for being socially responsible. Secondly, the paper adds to the literature of CSP in Indian context.

## **Review of Literature**

### Corporate Social Responsibility in India

Arora and Puranik (2004) brought out the fact that CSR is not something new in India. He criticized the trusts and foundations created and adopted by the Indian corporate to undertake CSR and said that these trusts prevent the company from mainstreaming of CSR into the core business and limit CSR to community development only. He also emphasized that in India, there is a need to increase the understanding and active participation of business in equitable social development as an integral part of good business practice.

Sagar (2004) talked about a survey which revealed that the Indian corporate are moving from philanthropy towards an integration of CSR with the business vision and processes. Arevelo and Arvind (2011) who studied Indian firms listed with UNGC, concluded that the Indian firms are

now moving towards the stakeholder model of CSR rather than giving importance only to the owners and shareholders and focusing only on the profit maximizing function. Sharma and Tyagi (2010) found that international organizations like Global Compact are well accepted by the Indian corporate, however, some companies lack in reporting to the Global Compact.

Arevalo and Arvind (2011) pointed out that current research on CSR in India consists of nature of CSR in India, perceptions of Indian society and businesses on CSR, corporate social reporting, practices of TNC's in India and the authors themselves linked CSR in India to the stakeholder model.

Balasubramaniam et al. (2005) studied the reasons for changing perception of CSR in India which include the reasons ranging from political setup to extreme poverty to religious settings leading to business benevolence. They also pointed towards the development imperative in the country which can bring about a tremendous change in the CSR activity in India.

Vancheswaran and Gautam (2010) concluded that social responsibility is neither new with the small and medium enterprises (SME's) in India as they have been found to contribute towards the marketing efforts of the SME's.

As far as the performance of Indian companies is concerned, Mittal et al. (2008) who studied the correlation between the economic value and CSR in the Indian corporate concluded that the management of the companies needs to devise ways of integrating CSR in their operations.

### Corporate Social Performance

Mostly, CSP has been used as a synonym of corporate social responsibility (Wartick and Cochran, 1985). Carroll (1979) took the lead of separating the two concepts and gave a three dimensional framework on corporate social performance which consisted of a pyramid of corporate social responsibility, the concept of corporate social responsiveness and the issues of social concern and management. All three together give corporate social performance.

Wartick and Cochran (1985) defined Corporate social performance as the integration of the principles of social responsibility, the process of social responsiveness and the policies

developed to address social issues. Wood (1991) defined CSP is an integration of the principles of corporate social responsibility, processes of corporate social responsiveness and the outcomes of corporate behavior. She further indicated that the social impacts, social programs and social policies constitute the third component of outcomes of the corporate behavior

For some people, understanding corporate social responsibility and taking an action on it is sufficient. On the surface, measurement is one part of dealing seriously with an important matter (Carroll, 2000). Theoretically speaking, businesses, in order to sustain their existence, depend on society. Therefore, they constantly strive to pattern their activities so that they are in congruence with the goals of the overall social system (Prakash Sethi, 1979). The study of corporate social performance is important so that there exists no gap between the social goals and business actions. Measuring the business case for CSR can help companies in the selection and management of CSR activities. (Drews, 2010).

The importance of CSP measurement is its role in tracking and ultimately influencing the creation and resolution of the gaps between the expectations of the stakeholders and their fulfillment. CSP measurement is also important to experience the effects of corporate actions and evaluating how firms are performing (Wood and Jones, 1995).

Pojasek, 2009, said performance can be monitored and improved with carrots (leading indicators) or with sticks (lagging indicators).

The authors have applied number of methods to measure corporate social performance. Some of the methods used by researchers are expert evaluation of the corporate policies of the firm (Abbott and Monsen, 1979); content analysis of the annual reports and other corporate documents (Cochran and Wood, 1984); proxy measures like controlling pollution (Mcquire et al., 1988) etc.

Reputational surveys and ratings given by external agencies like Innovest, KLD (Kinder, Lydenberg and Domini), ARESE, LBG, JRA, Fortune Social Responsibility Index etc. give ratings to companies based on their social performance. In India, only one social rating agency 'Karmayog' is in existence which gives annual ratings to all companies. The rating is assigned based on the CSR initiatives of the company for the time period of the study, including a comparison with previous years' CSR initiatives ([www.karmayog.com](http://www.karmayog.com)). The procedure followed

by the Karmayog is not very rigorous as it focuses only on community initiatives of the company.

The current study will be focusing on the process approach of measuring corporate social performance of the companies. To understand the social performance of a company, two primary indicators of social performance have been identified from the review of literature, namely, strategic governance and social performance towards the primary stakeholder groups.

**Strategic Governance** is understood by the authors as how does the company strategically govern its social responsibility activities. Strategic governance fundamentally points out whether the company has integrated CSR in its blood stream or is it only superficially engaging in it. Some of the indicators of strategic governance identified are shareholder activism (Guay et al. 2004), CSR representation on the board of the company, management skilled in environmental scanning and information processing (Galbreath, 2010), CSR interventions undertaken with the intentions to create business opportunities (Bhattacharya et al. 2008) etc.

**Responsibility towards stakeholder groups** has been emphasized by number of researchers (Clarkson, 1995; Harrison and Freeman, 1999; O’Riordon and Fairbrass, 2008). Clarkson (1995) proposed that corporate social performance can be effectively analyzed and evaluated using the stakeholder approach. Brammer and Millington (2003) suggest that stakeholder wants and preferences play a pivotal role in shaping social involvement activities of the companies. Hillman in 2001 studied whether having representation of stakeholders on the board of directors’ impacts firm’s social performance.

## **Objectives**

1. To assess the social performance of selected PSU’s in India.
2. To study the corporate social performance of selected Indian Public sector companies with regard to their strategic governance.
3. To study the corporate social performance of selected Indian Public sector companies with regard to their stakeholders dimensions.

4. To find out whether there is a relationship between the strategic governance and the stakeholders' social performance of the PSU's.

## **Research Methodology**

### **1. Sampling Frame**

PSU's in India have been categorized on the basis of Public Sector Banks, Central Public Sector Enterprises (CPSE's) and Public Sector Enterprises. CPSE's have been further classified on the basis of performance; three categories of PSU's are Maharatnas, Navratnas and Mini Ratna ([www.india.gov.in](http://www.india.gov.in)). On the basis of these titles, the companies have different level of autonomy to compete on the global platform. Maharatnas are those companies which have an average annual turnover of Rs. 20,000 cr during the last three years of operation and the average annual net worth of the company should be Rs. 10,000 cr. These companies have empowered status in terms of their investment decisions upto Rs. 5000 cr without Government approval. The Navratna status does not depend on their turnover but these companies have enhanced powers in capital expenditure; equity investment in joint ventures/subsidiaries in India or abroad, human resources development, organizational restructuring and raising of debt from the domestic capital markets and borrowings from international markets. To get the Miniratna status, the company should be profitable for the last three years and should have a positive net worth. However, there are seventeen companies which fall under this category; five Maharatnas and twelve Navratnas.

### **2. Content Analysis**

Content Analysis is a technique for gathering data that consists of codifying qualitative information in anecdotal and literary form into categories in order to derive quantitative scales of varying levels of complexity (Abbott and Monsen, 1979). Guthrie and Abeysekera (2006) quote Parker (2005) that the content analysis has been used as a frequently used method in social and environmental accounting researches. In CSR researches, authors have been counting the number

of lines of prose devoted to social responsibility in the annual reports of the companies, number of paragraphs devoted to the column of CSR in Annual Reports, number of lines in the Directors Message and in Management Discussion & Analysis (in the annual reports) etc (Moneva, 2007, Bowman and Haire, 1975, Alon et al., 2010).

To assess the social performance of the companies, secondary data has been used. Content analysis of the reports of the public sector enterprises has been done. The content of the annual reports was analyzed wherein the researcher looked for the presence of the indicators of determinants of corporate social performance. Out of the total 32 indicators (6 for strategic governance and 26 for stakeholder performance), 15 indicators were dropped after the analysis as they were not found adequately in the annual reports of the PSU's studied. The indicators which were dropped were probably not relevant in the context of Indian PSU's.

The indicators of Strategic Governance finally retained for analysis are:

1. Separate CSR Department
2. Strategic direction documented
3. Undertake reporting/disclosure practices
4. Shareholder activism

Four primary stakeholders which are being considered in the study are as under:

1. Employees
2. Community
3. Investors
4. Customers

Indicators related to social responsibility towards the above stakeholders have been identified. The indicators are customers' health and safety through production of safe products, commitment to product quality, employment of minority groups, provision of training to the employees, monitoring of employee satisfaction level, employee safety, implementation of community support programmes, performance measurement of these programmes, holding

stakeholder engagement activities, support to non-profit organizations, investor grievance handling policies and dividend payment policy.

## Analysis and Discussion

On the basis of the content analysis, a matrix was formed for both the determinants of corporate social performance. The companies were identified in good, medium and poor categories for both the determinants.

SG Perf STK Perf	G	M	P	
G	6	-	-	6
M	3	3	5	11
	9	3	5	17

In the above matrix, we found that six companies were such which performed well on both the dimensions. Three companies performed good on the strategic governance but medium on the stakeholder dimension. There were three companies which again performed medium on both the dimensions. While there were five companies which performed poor on the strategic governance dimension but medium on the stakeholder dimension.

As far as the above analysis is concerned, the six companies which performed well on both the dimensions are the exemplary companies. Amongst these six, five are maharatnas and only one is a navratna PSE. These companies represent the optimum condition wherein strategic governance is good leading to good social performance towards the stakeholders.



Jones (1995) conveyed the message that corporate social performance is about establishing trust and cooperative relationship between the firm and the stakeholders. If the company strategically governs its CSR activities with the help of tools like entertaining shareholder activism, CSR representation on the board of the company etc. it is in fact winning the trust of the shareholders and of the stakeholders. An example of strategic governance is Maharatnas Company ONGC which has been recognized globally for its transparency and disclosure practices. Indian Oil Corporation (IOC) has constituted a committee of Directors for CSR and as an example of responsibility towards public welfare; it has started a Rural Retail initiative.

The three navratna companies which show up medium performance towards stakeholders but seem to have good strategic governance need deeper investigation. Further, a research needs to be undertaken to identify the reasons for medium performance towards the stakeholders while the companies have strategically governed their CSR agenda and activities. This is because identification of stakeholder needs and fulfilling those needs with the help of stakeholder engagement is an integral part of strategic CSR.

The other three and five companies show medium stakeholder performance with medium and poor strategic governance respectively. For such companies, if the strategic governance of their CSR interventions is undertaken, they would show an enhanced social performance towards their stakeholders. As Pederson and Rendtorff (2010) put it, 'CSR is an instrument that is supposed to make corporations more aware of their responsiveness to society in a sense that it can also be viewed as an instrument that improve competitive abilities.' Seeking CSR strategically will affect the whole ideology of CSR in a company and hence will direct the process of CSR which is more streamlined and integrated with the company's mission statements.

The analysis leads us to two conclusions: First, High social performance towards the stakeholders leads to good governance. Good Governance here acts as an effect. In good companies like ONGC, good strategic governance is an effect of good stakeholder performance. Secondly, poor governance leads to low stakeholder performance. In poor socially performing companies like HAL, strategic governance is a cause and hence, poor governance implies poor performance towards the stakeholder.

So following the law:

<p>if <math>P \Rightarrow Q</math>, then <math>\neg Q \Rightarrow \neg P</math></p>
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Good strategic governance should lead to high social performance towards the stakeholders. Pederson and Rendtorff (2010) tried to explain how the public sector institutions can follow private sector to improve their economic efficiency along with undertaking value driven management of all stakeholders. However, it can be either ways. Whichever company, public or private, takes care of its stakeholders and integrates CSR in the core strategy of doing business will have good CSR performance.

## **Conclusion**

The Central Public Sector Enterprises in India turned out to be the average performers in CSR performance as only (approximately) 50% companies show good performance. The companies have started to tread on the path of social responsibility by strategically governing the CSR agenda and by being responsible towards their stakeholders. In the strategic governance dimension of CSP, most of the companies have included strategic CSR in their vision and mission documents and have a separate CSR office. This shows that companies realize that they are responsible for the welfare of the stakeholders. In the light of such a realization, the companies entertain the shareholders concerns and also try to be transparent by reporting their financial as well as social performance.

In the stakeholders dimensions, approximately half number of the companies are taking care of stakeholders responsibility while the other half are yet to follow.

The study brings out the relationship between the strategic governance and stakeholders dimension clearly. There is positive relationship between strategic governance and responsibility towards the stakeholders with strategic governance leading to the stakeholder responsibility.

## **Limitations**

The study is limited to the Maharatnas and Navratnas only. More accurate results of PSU performance with respect to strategic governance and social performance towards the stakeholders can be obtained if this study is extended to all Central Public Sector Undertakings.

The above findings are based on the analysis of annual reports. Companies have different ways of preparing their annual reports. While some emphasize on their economic performance, the others emphasize on social performance which brings anomaly in the results. Further, reports vary from sector to sector.

### **Suggestions for further Research**

CSP of the PSU's can be more accurately measured by combining the content analysis with other methods of collecting information including personal interviews, analyzing other publicly available documents. A sectorwise study could also be undertaken to get a deeper understanding of the subject.

### **References**

- Abott, W. F. & Monsen, R. J. (1979). On the measurement of CSR- Self Reported Disclosure as a method of measuring corporate social involvement, *Academy of Management Journal*, 22(3), 501-515
- Arevalo, J. and Arvind, D. (2011) Corporate Social Responsibility practices in India: approach, drivers and barriers, *Corporate Governance*, 11(4), 399-414
- Alon, I., Lattemann, C., Fetscherin, M., Li, S., & Schneider, A.-M. (2010). Usage of public corporate communications of social responsibility in Brazil, Russia, India and China (BRIC). *International Journal of Emerging Markets*, 5(1), 6–22.
- Balasubramaniam, N. K., Kimber, D. and Siemensma, F. (2005). Emerging Opportunities or Traditions Reinforced? An Analysis of the Attitudes towards CSR, and Trends of Thinking About CSR, In India, *The Journal of Corporate Citizenship*, 17, 79-92

- Bhattacharyya, S. S., Sahay, A., Arora, A. P. and Chaturvedi, A. (2008). A toolkit for designing firm level strategic corporate social responsibility (CSR) initiatives, *Social Responsibility Journal*, 4(3), 265-282
- Brammer, S. and Millington. A. (2003). The effect of Stakeholder Preferences, Organizational Structure, and Industry Type on Corporate Community Involvement, *Journal of Business Ethics*, 45, 213-226
- Bowman, E. & Haire, M. (1975). A strategic posture towards corporate social responsibility, *California Management Review*, 18(2), 49-58
- Carroll, A. B. (1979). A three Dimensional Conceptual Model of Corporate Performance, *Academy of Management Review*, 4(4), 497-505
- Carroll, A. B. (2000). A commentary and review of key questions of CSP measurement, *Business and society*, 39(4), 466-478
- Clarkson, M. (1995). A stakeholder framework for analyzing and evaluating CSP, *Academy of Management Review*, 20(1), 92-117
- Cochran, P. L. and Wood, R. A. (1984). Corporate Social Responsibility and Financial Performance', *Academy of Management Journal* 27(1), 42-56
- Drews, M. (2010). Measuring the business and societal benefits of corporate responsibility, *Corporate Governance*, 10(4), 421-431
- Galbreath, J. (2009). Building corporate social responsibility into strategy, *European Business Review*, 21(2), 109-127
- Guay, T., Doh, J., Sinclair, J. (2004). NGO's, shareholder activism and socially responsible investments: Ethical, strategic and governance implications, *Journal of Business Ethics*, 52(1), pp 125
- Gupta, A. D. (2007). Social Responsibility in India towards Global Compact approach, *International Journal of social economics*, 34(9), 637-663

- Guthrie, J. and Abeysekera, I. (2006). Content analysis of social, environmental reporting: what is new? *Journal of Human Resource Costing & Accounting*, 10(2), 114-126
- Harrison, J. S. and Freeman, R. E. (199). Stakeholders, Social Responsibility and Performance, *Academy of Management Journal*, 42(5), 479-485
- McGuire, J. B., Sundgren, M. and Schneeweis, T. (1988). Corporate Social Responsibility and Firm Financial Performance, *Academy of Management Journal* 31(4), 854-87
- Mittal, R. K., Sinha, N. and Singh, A. (2008). An analysis of linkage between economic value added and corporate social responsibility, *Management Decision*, 46(9), 1437-1443
- Moneva, J. M., Juana M. R. L and Mari'a J. M. T. (2007). The Corporate Stakeholder Commitment and Social and Financial Performance, *Industrial Management & Data Systems*, 107 (1), 84-102
- O'Riordon, L and Fairbrass, J. (2008). Corporate Social Responsibility: Models and Theories in stakeholder dialogue, *Journal of Business Ethics*, 83, 745-758
- Pederson, J. S. and Rendtroff, J. D. (2010). Balancing values and economic efficiency in the public sector! What can public welfare service institutions learn from private service firms?, *Society and Business Review*, 5(3), 2010, 293-302
- Pojasek, R. B. (2009). Sustainability performance Addressing the Now with Intention to the future, *Environmental Quality Management*
- Sagar, P. and Singla, A. (2004). Trust and Corporate Social Responsibility- Lessons from India, *Journal of Communication Management*, 8(3), 282-290
- Sethi, S. P. (1975). Dimensions of corporate social responsibility, *California management review*, 17(3), 58-64
- Sharma, A. K. and Tyagi, R. (2010). CSR and Global Compact: The Indian Perspective, *The IUP Journal of Corporate Governance*, 9(3)

- Vancheswaran, A. and Gautam, V. (2010). CSR in SMEs: Exploring a Marketing Correlation in Indian SMEs, *Journal of Small Business and Entrepreneurship* 24(1), 85–98
- Wood, D J. (1991). Corporate Social Performance Revisited, *Academy of Management Review*, 16 (4), 691-718
- Wood, D.J. and Jones, R.E. (1995), Stakeholder mismatching: a theoretical problem in empirical research on corporate social performance, *The International Journal of Organizational Analysis*, 3, pp. 229-67
- [www.india.giv.in](http://www.india.giv.in)
- [www.karmayog.com](http://www.karmayog.com)

## Annexure

### 1. Strategic Governance performance

Indicators:

1. Separate CSR Office
2. Strategic direction documented
3. Undertake reporting/disclosure practices
4. Shareholder activism

Company	Name	SG Perf	Co. Score	1	2	3	4
1	ONGC	G	4	1	1	1	1
2	NTPC	G	4	1	1	1	1
3	SAIL	G	3	1	1	1	0
4	IOC	G	3	1	1	1	0
5	CIL	G	3	1	1	1	0
6	BEL	G	3	1	1	1	0
7	BHEL	P	1	0	1	0	0
8	BPCL	P	1	0	1	0	0

9	GAIL	P	1	1	0	0	0
10	HAL	P	1	1	0	0	0
11	HPCL	M	2	1	1	0	0
12	NALCO	G	3	1	1	1	0
13	NLL	M	2	0	0	1	1
14	NMDC	M	2	0	1	0	1
15	OIL	P	0	0	0	0	0
16	PGCL	G	3	0	1	1	1
17	RIN	G	3	1	0	1	1

G- Good, M- Medium, P- Poor

Scale: Good: 3 and 4, Medium: 2, Poor: 1 and 0

## 2. Performance towards Stakeholders

**Indicators are:** 1. Customers' Health and Safety through production of safe products, 2. Commitment to product quality, 3. Employment of minority groups, 4. Provision of training to the employees, 5. Monitoring of employee satisfaction level, 6. Employee safety, 7. Grievance Redressal for employees, 8. Implementation of community support programmes, 9. Performance measurement of these programmes, 10. Holding stakeholder engagement activities, 11. Support to non-profit organizations, 12. Investor grievance handling policies and dividend payment policy, 13. Policy of paying dividend

Company	Name	Perf.	Co.Score	1	2	3	4	5	6	7	8	9	10	11	12	13
1	ONGC	G	13	1	1	1	1	1	1	1	1	1	1	1	1	1
2	NTPC	G	13	0	1	0	1	1	1	1	1	1	1	1	1	1
3	SAIL	G	13	1	1	1	1	1	1	1	1	1	1	1	1	1
4	IOC	G	13	1	1	1	1	1	1	1	1	1	1	1	1	1
5	CIL	G	13	0	1	1	1	1	1	1	1	1	1	1	1	1
6	BEL	M	7	1	1	1	1	0	1	0	1	0	0	1	0	0
7	BHEL	M	9	0	1	1	1	1	1	0	1	0	0	0	1	1
8	BPCL	M	9	1	1	1	1	0	1	0	1	0	1	1	0	1
9	GAIL	M	8	0	1	1	1	1	1	0	1	1	0	0	0	1

10	HAL	M	6	0	1	1	0	1	0	0	1	0	0	0	0	1
11	HPCL	M	9	1	1	1	1	0	1	0	1	0	0	1	0	1
12	NALCO	M	9	1	1	0	0	0	1	0	1	1	1	0	1	1
13	NLL	M	7	0	1	1	1	0	1	0	1	0	0	0	0	1
14	NMDC	M	8	0	1	1	0	0	1	0	1	0	0	1	0	1
15	OIL	M	8	0	1	1	1	1	1	0	1	0	0	0	1	1
16	PGCL	G	10	1	1	0	1	1	0	1	1	0	0	0	1	1
17	RIN	M	9	0	1	1	1	0	1	1	1	0	0	0	0	1

G- Good, M- Medium, P- Poor

Scale: Good: 10 - 13, Medium: 5 – 9, Poor: 1 - 4

### 3. CSP performance

Company	Name	Overall Performance	Performance Grade
1	ONGC	104	G
2	NTPC	104	G
3	SAIL	91	G
4	IOC	91	G
5	CIL	91	G
6	BEL	67	M
7	BHEL	49	P
8	BPCL	49	P
9	GAIL	45	P
10	HAL	37	P
11	HPCL	62	M
12	NALCO	75	M
13	NLL	54	P
14	NMDC	58	P
15	OIL	32	P
16	PGCL	79	G
17	RIN	75	G

G- Good, M- Medium, P- Poor

Scale: Good: 75 – 105, Medium: 60 – 75, Poor: Below 75





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**HIGHER EDUCATION VISION AND MISSION DEVELOPMENT STRATEGIES THAT  
RELATE TO THE ENVIRONMENTAL RANKING OF A UNIVERSITY**

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**ABSTRACT**

The relationship between establishing an environmental vision for a higher education institution and having a sustainable campus was explored. The goal of this study was to determine whether a highly developed vision was required for the success of a highly functioning institution. The connection between an established vision and the possible success toward environmental sustainability on institutional campuses emerged from the Talloires Declaration of 1990, one of several documents intent on improving college and university campuses. This exploration contributed to an advanced framework based on a sustainable network theory.

The Spearman *rho* correlation coefficient was used to determine the magnitude and the direction of the relationships between leadership strategy stages and institutional environmental sustainability rankings. No significant predictions were found between an established institutional vision and the advancement of environmental sustainability on institutional campuses. In addition, a simple regression was used to predict the environmental sustainability ranking of an institution listed in the “Green Report Card” in relation to the degree of leadership strategy implemented. No significant predictions were found.

**Introduction**

Movements toward environmentally sustainable practices and accompanying implementation plans on college campuses and on business grounds have been growing exponentially and recorded in articles and journals around the world. Environmental issues have been addressed in the political arena and consumers have voiced their need for change regionally and internationally. Interestingly, Venetoulis (2001) stated that “green” (those components that reduce consumption and waste) improvements have been taking place on campuses since the 1960’s. Since the 1960’s, improvements have waned due to a gradual loss of interest in environmental issues and the ever-rising cost of resources that would be used for green building materials. However, there are benefits for colleges, universities and businesses that seek a transition toward sustainable campuses. Carlson (2008) stated that colleges and universities with advanced environmental programs and environmentally sustainable campuses may have unique

advantages over campuses that do not utilize sustainable practices. Sustainable practices, according to Carlson could result in an increased student population, a probable reduction in tuition that would be linked to a reduction of operational costs for an institution, increased grant obtainment by institutions and increased environmental programs that would be available by the institution. Other, more recognizable outcomes, according to Carlson, could include a reduction in campus energy consumption and related costs and the use of renewable energy and building materials that would reduce operational costs in future years.

With all of the benefits mentioned, it is no wonder that institutions are donning an interest in campus modification. Institutions could possibly lead the way within communities and make a significant impact on the environment. At least that is the expectation of organizations such as the Higher Education Association's Sustainability Consortium (2005) or acts such as the Talloires Declaration of 1990. Roorda (2001) stated that international declarations offer strategies for environmental sustainability but no operative procedures. The Talloires Declaration (1990), Agenda 21 (1992) and Society for College and University Planning (SCUP), to name a very few significant policies, suggested that universities that have a developed vision toward sustainability would most likely be successful in transitioning college and universities to environmentally sustainable campuses. The question then becomes would having a vision toward environmental sustainability be enough to establish sustainable practices on college campuses. If so, is there a stage of development of a vision that would be best suited toward environmental sustainability within the higher education leadership structure.

### Methodology

The Auditing Instrument for Sustainability in Higher Education (AISHE), organized by Niko Roorda and associates (2001) was one of two tools used in the study to examine the role of vision development in the progression of environmental sustainability on institutional campuses. The tool was selected to identify leadership strategies, and implementation stages used among university leaders in the United States. AISHE, version one, utilized the concepts of transformational leadership theory and strategic choice theory intricately. The assumption that higher education leaders need to be the mechanism for change within the institution and conduct change through data driven sources is a transformational leadership concept noted by Burns (1978). In addition, Chase and Rowland (2004) emphasized the role of strategic planning, and the importance of strategic choice among leaders. The second tool used in this study to ascertain whether having a vision towards environmental sustainability was a significant enough strategy to generate environmental sustainability was the college sustainability report card: A review of campus and endowment policies at leading institutions (2008) developed by the Sustainable Endowments Institute annually. The college sustainability report card or Green Report Card provided comparative information among colleges and universities that were intended to promote awareness of environmental sustainability. The sustainable report card also provided a clear and systematic evaluation through the submission of the following information and used a mixed method approach. The report provided an overview of the methods used for collecting data. Questions used in the survey referred to the following evaluation areas: administration, climate change & energy, food & recycling, green building, transportation, endowment information, investment priorities, and shareholder engagement.

The study was a quantitative, descriptive, non-experimental design where a total of 284 colleges or universities were selected from a population of 332 institutions that were included in the College Sustainability Report Card (2010). The study analyzed both public and private institutions within the United States. University leaders completed a survey instrument that collected leadership strategy stages implemented at their institutions. The data was quantitative. The survey was retrieved from the Auditing Instrument for Sustainability in Higher Education created by the Dutch national working group for Criteria for Sustainable Higher Education and Roorda (2001).

The research question for this study reflected leadership strategies identified in the Auditing Instrument for Sustainability in Higher Education developed by Roorda (2001). These leadership strategies were originally noted in such documents as the Talloires Declaration of 1990. Stages for each strategy ranged from 0, a stage of non activity within the institution to stage 5, which was a stage of maximum strategy implementation activity within the institution. The research question was designed to assess the correlation of the leadership strategy stage of vision development to the environmental ranking of an institution. Environmental rankings were displayed within the 2010 College Sustainability Report Card and issued by the Sustainable Endowments Institute (Orlowski, 2005). Letter grades between A- and F represented the environmental ranking scores.

## Results

A Spearman *rho* correlation coefficient was calculated to determine the relationship between the stages of implementing a vision and the environmental ranking score of the institution. The research question: Is there a significant relationship between the degree of development of an environmental vision and the environmental ranking of a university?  $H_{01}$  stated that the two ordinal variable rankings were independent of each other.  $H_{11}$  stated that for a two tailed test, there would be a significant nonzero correlation between vision strategy stages and the environmental ranking of an institution. Table 1 displays a correlation that was non-significant ( $r(86) = .065, p > .05$ ). Vision strategy stages are not related to the environmental ranking of an institution. The results of this test failed to reject the first null hypothesis (see Table 1).

In this study, implementation stages (0-5) reflected the development of a specific leadership strategy. If the implementation stage for developing a vision was identified as a one by a university leader, then the vision for that institution was poorly identified and formulated. Whereas, if the implementation stage was identified as a five, then the vision statement was well known throughout the institution community and identifiable by institution stakeholders. Examined institutions reported low to moderate vision development between stages 0 and 4 (see *Figures 2-5*). Vision was present, but fell behind varying leadership strategies throughout all stages of development. However, the second most frequent strategy implemented at stage 5 was the formulation and development of an institution wide vision. In essence, having a vision was not identifiable within an institution until it was well developed and distributed. AISHE suggests that an institution should have a vision of sustainable development that utilizes the expertise available to the organization. The vision of sustainable development should be clear and the consequences of implementation should be known to all stakeholders. At stage 5 it is an expectation that the vision is integrated into the sustainable developmental goals of society (see *Figure 6*).

## Conclusion

In the case of needing a developed vision toward environmental sustainability on college and university campuses, it is possible that once stages 1, 2, or even 3 are met by higher education institutions, higher stages of implementation would no longer significantly influence the advancement of environmental sustainability on university campuses. Perhaps the introduction of a vision or mission, in and of itself is enough to generate change. Another possibility for a non significant outcome between vision development for environmental sustainability and the environmental ranking of an institution among a ranking system, such as The Green Report Card, would be that strategies were not powerful enough to work individually and required a synergistic interaction among other strategies in order to generate change toward environmental sustainability. Last, non significance between vision development and the environmental sustainability ranking of an institution can be interpreted as additional support for institutions that choose to transition toward sustainability as a unique entity. Institutions may be better suited to following individualized pathways toward sustainability rather than following a cookie cutter model. Although leadership strategy stages were not concretely identified in this study, perhaps methods suggested by the National Wildlife Federation (2008), the Talloires Declaration (1990), and the 2010 American College and University President's Climate Commitment (ACUPCC) are more appropriate. According to these sources, institutions should take an individualized approach to the utilization of leadership strategies and methods among campuses.

## References

- AASHE. (2010, January 19). Sustainability tracking and rating system. Retrieved March 6, 2010, from STARS program overview:  
[http://stars.aashe.org/pages/faqs/4101/?root\\_category=about](http://stars.aashe.org/pages/faqs/4101/?root_category=about)
- Agenda 21. (1992). Division for sustainable development. Retrieved March 3, 2009, from  
[http://www.un.org/esa/dsd/agenda21/res\\_agenda21\\_00.shtml](http://www.un.org/esa/dsd/agenda21/res_agenda21_00.shtml)
- American College and University Presidents Climate Commitment. (2010). Text of the American college and university presidents climate commitment. Retrieved May 3, 2010, from <http://www.presidentsclimatecommitment.org/about/commitment>
- Association for the Advancement of Sustainability in Higher Education. (2001). About AASHE. Retrieved March 8, 2009, from <http://www.aashe.org/about>
- Bass, B. (1985). Leadership and performance beyond expectation. New York, NY: Free Press.
- Bass, B. (1990). From transactional to transformational leadership: Learning to share the vision. *Organizational Dynamics* , 19-31.
- Bourdieu, P. (1986). The forms of capital. Westport, Connecticut: Greenwood Press.
- Bourdieu, P. (1991). Language and symbolic power. Cambridge, Massachusetts: Harvard University Press.
- Bourdieu, P. (1996). The state nobility: Elite schools in the field of power. Cornwall: Polity Press.
- Bradley, G. (2008). College costs continue to increase. *Academe*, 94(1), 10. Retrieved June 29, 2008, from Research Library database. (Document ID: 1442468811).
- Brainard, J. (1999). EPA offices push colleges to comply with environmental regulations. *Chronicle of Higher Education* , 45 (44), 32.

- Brody, S., & Ryu, H. (2006). Measuring the educational impacts of a graduate course on sustainable development. *Environmental Educational Research* , 12, 179-199.
- Brundtland Commission. (1987). Report of the world commission on environment and development: Our common future. Oxford: NGO Committee on Education.
- Brundtland Report. (1987). Our common future: Report of the world commission on environment and development. New York: Oxford University Press.
- Burns, J. (1978). Leadership. New York: Harper & Row.
- Calder, W., & Clugston, R. (2002). Higher education: Stumbling toward sustainability. Washington, DC: Environmental Law Institute.
- Calhoun, T., & Cortese, A. (2005). We rise to play a greater part: Students, faculty, staff, and community converge in search of leadership from the top. Ann Arbor, Michigan: Society for College and University Planning.
- Carlson, S. (2008). How green was my college. *Chronicle of Higher Education* , 54 (34), 4-5.
- Chase, G., & Rowland, P. (2004). The Ponderosa Project: Infusing sustainability in the curriculum. In P. F. Barlett & Geoffrey W. Chase (Eds.). *Sustainability on campus: stories and strategies for change*. Cambridge, MA: MIT Press.
- Cohen, J. (1988). Statistical power analysis for the behavioral sciences. New York, NY: Academic Press.
- College Sustainability Report Card. (2009). The college sustainability report card: schools. Retrieved May 5, 2008, from <http://greenreportcard.org/report-card-2009>
- College Sustainability Report Card. (2010). The college sustainability report card: schools. Retrieved October 24, 2009, from <http://www.greenreportcard.org/report-card-2010/schools>
- Conway, T., Dalton, C., Loo, J., & Benakoun, L. (2008). Developing ecological footprint scenarios on university campuses: A case study of the university of Toronto at Mississauga. *International Journal of Sustainability in Higher Education* , 9 (1), 4-20.
- Cortese, A. (2003). The critical role of higher education in creating a sustainable future. *Planning for Higher Education* , 31 (3), 15-22.
- Cortese, A. (2007, June). Higher education leadership in reversing global warming and creating a healthy, just, and sustainable society. Annual meeting for the Annapolis Group, Annapolis MD.

Creswell, J. (2005). *Education research: Planning, conducting, and evaluating quantitative and qualitative research*. Upper Saddle River, NJ: Pearson Education.

Fiksel, J. (2006). Sustainability and resilience: Toward a systems approach. *Sustainability Science*, 2 (2), 14-21.

Grants for Renewable Energy Education for the Nation Act of 2009, H.R. 1775, 111th Cong. § 3 (2009).

Higher Education Association's Sustainability Consortium . (2005). About HEASC. Retrieved June 8, 2009, from <http://www2.aashe.org/heasc/about.php>

Kyoto Protocol. (1997). United Nations framework convention on climate change. Retrieved August 20, 2009, from [http://unfccc.int/kyoto\\_protocol/items/2830.php](http://unfccc.int/kyoto_protocol/items/2830.php)

Montreal Protocol. (1987). The Montreal protocol on substances that deplete the ozone layer. Retrieved August 20, 2009, from <http://ozone.unep.org/Publications/>

MP\_Handbook/Section\_1.1\_The\_Montreal\_Protocol/

Orlowski, M. (2005). Sustainable endowments institute. Retrieved October 2, 2008, from <http://greenreportcard.org/about/sustainable-endowments-institute>

Princeton Review. (2010). Green honor roll. Retrieved March 14, 2010, from <http://www.princetonreview.com/green-honor-roll.aspx>

Roorda, N. (2001). *Auditing Instrument for Sustainability in Higher Education*. Amsterdam: Stichting Duurzamm Hoger Onderwijs (DHO).

Shriberg, M., & Tallent, H. (2004). *Beyond principles: Implementing the Talloires Declaration*. Medford: University Leaders for a Sustainable Future.

Skinner, B. (1971). *Beyond freedom and dignity*. New York: Knopf Doubleday Publishing.

Sonnenfeld, D., & Mol, A. (2002). Globalization and the transformation of environmental governance: An introduction. *American Behavioral Scientist*, 9, 5-6.

Sustainability Tracking and Rating System. (2010). About AASHE STARS. Retrieved April 8, 2010, from <http://stars.aashe.org/pages/about/>

Sustainable Endowments Institute. (2009). About. Retrieved August 4, 2009, from <http://www.endowmentinstitute.org/about.html>

Talloires Declaration. (1990). Retrieved August 4, 2009, from [http://www.ulsf.org/programs\\_talloires\\_td.html](http://www.ulsf.org/programs_talloires_td.html)



United Nations. (1992, June 2-14). United Nations conference on environment and development. Retrieved May 4, 2009, from United Nations environment programme:  
[p://www.eoearth.org/article/United\\_Nations\\_Conference\\_on\\_the\\_Human\\_Environment\\_\(UNCHE\),\\_Stockholm,\\_Sweden](http://www.eoearth.org/article/United_Nations_Conference_on_the_Human_Environment_(UNCHE),_Stockholm,_Sweden)>

University Leaders for a Sustainable Future. (2010). Talloires Declaration. Retrieved December 2, 2010, from [http://www.ulsf.org/talloires\\_declaration.html](http://www.ulsf.org/talloires_declaration.html)

University of Florida TREEO Center. (2009). Environmental management systems institute. Retrieved November 9, 2009, from <http://www.treeo.ufl.edu/ems>

Venetoulis, J. (2001). Working toward sustainability: Successful community based efforts. East Hartford, Connecticut: Praeger.

Table 1  
*Correlation Between Vision Development Stages and SEI Grades*

			Grade	Vision
Spearman's rho	Grade	Correlation Coefficient	1.000	.065
		Sig. (2-tailed)	.	.546
		N	88	88

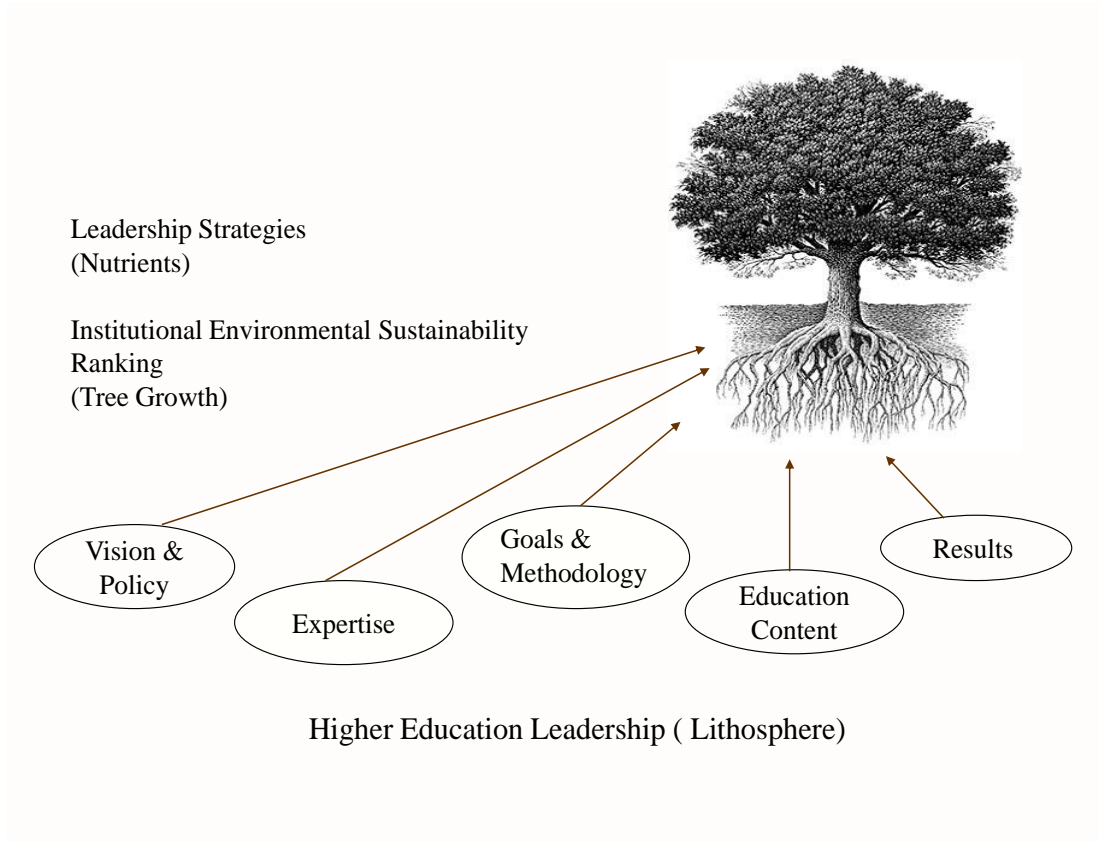


Figure 1. Leadership strategies as nutrients to promote environmental sustainability.

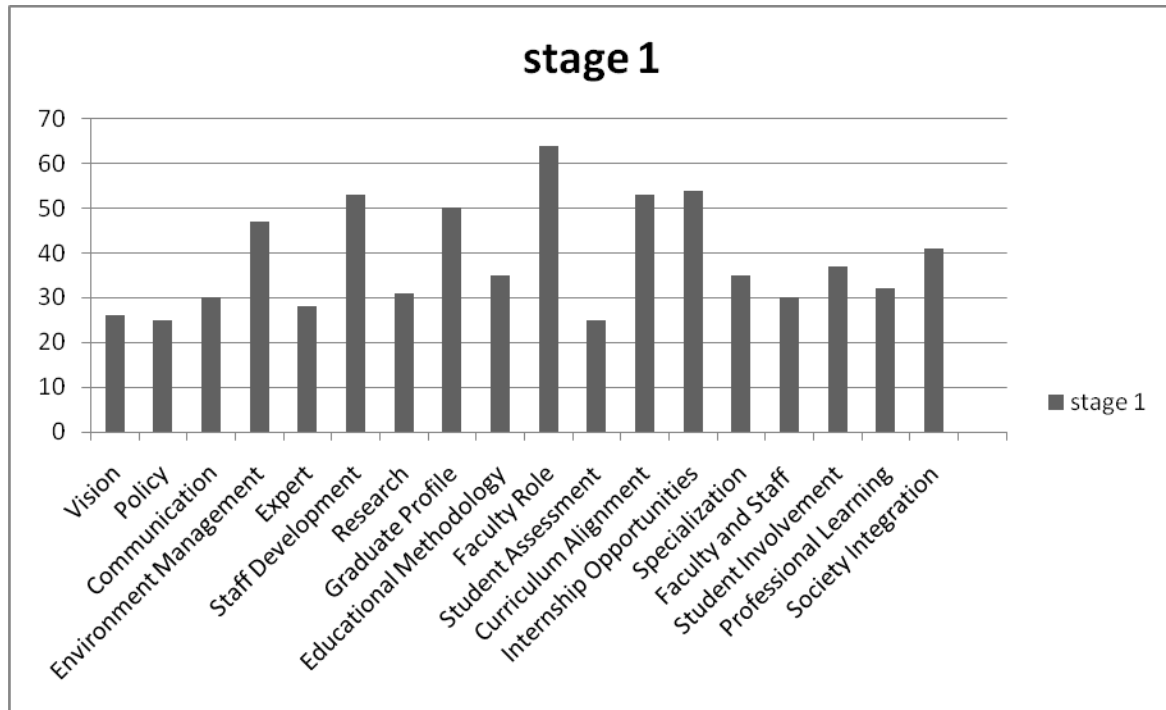


Figure 2. Frequency of higher education institutions at implementation stage 1.

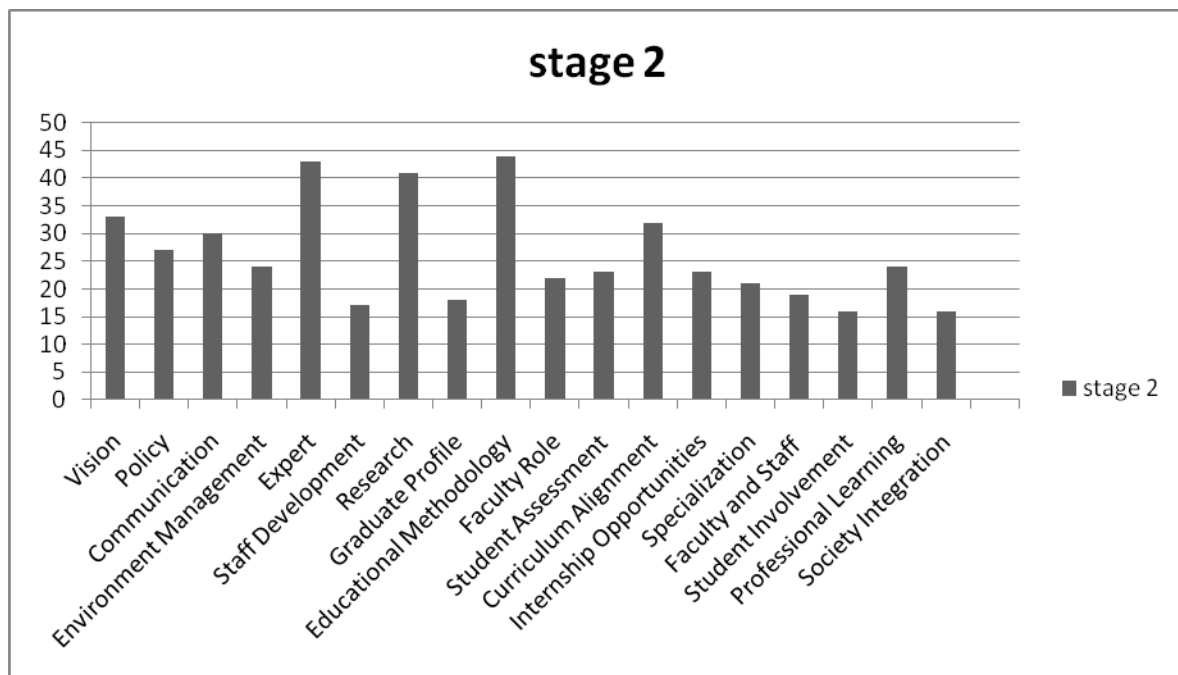


Figure 3. Frequency of higher education institutions at implementation stage 2.

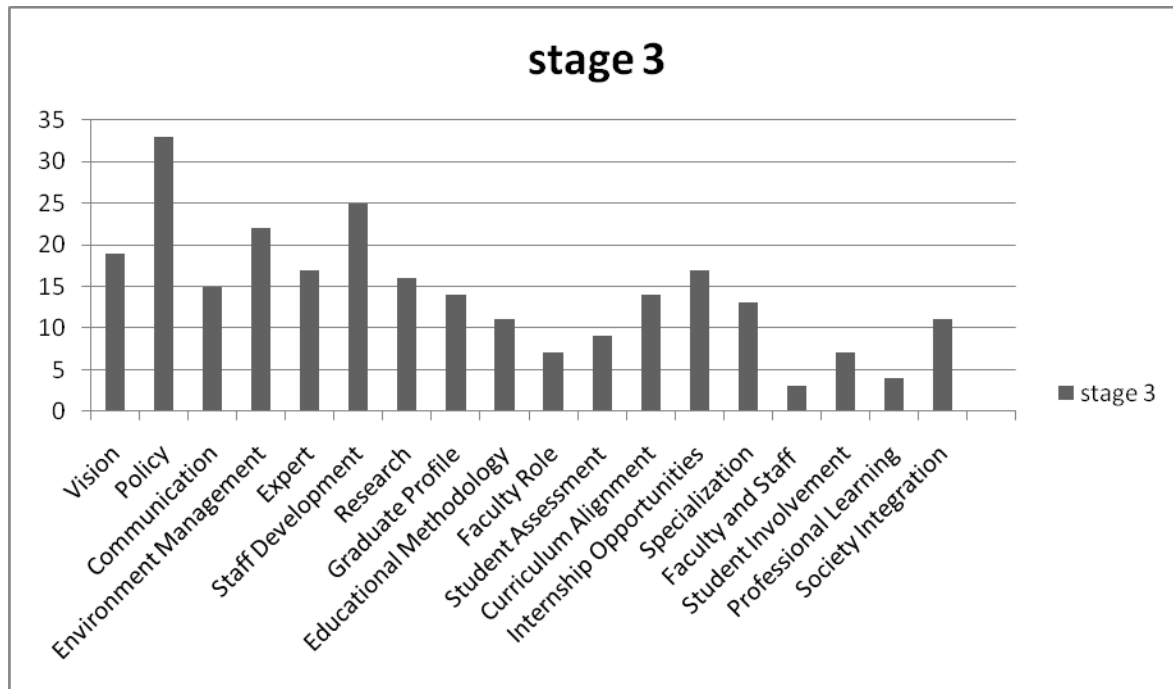


Figure 4. Frequency of higher education institutions at implementation stage 3.

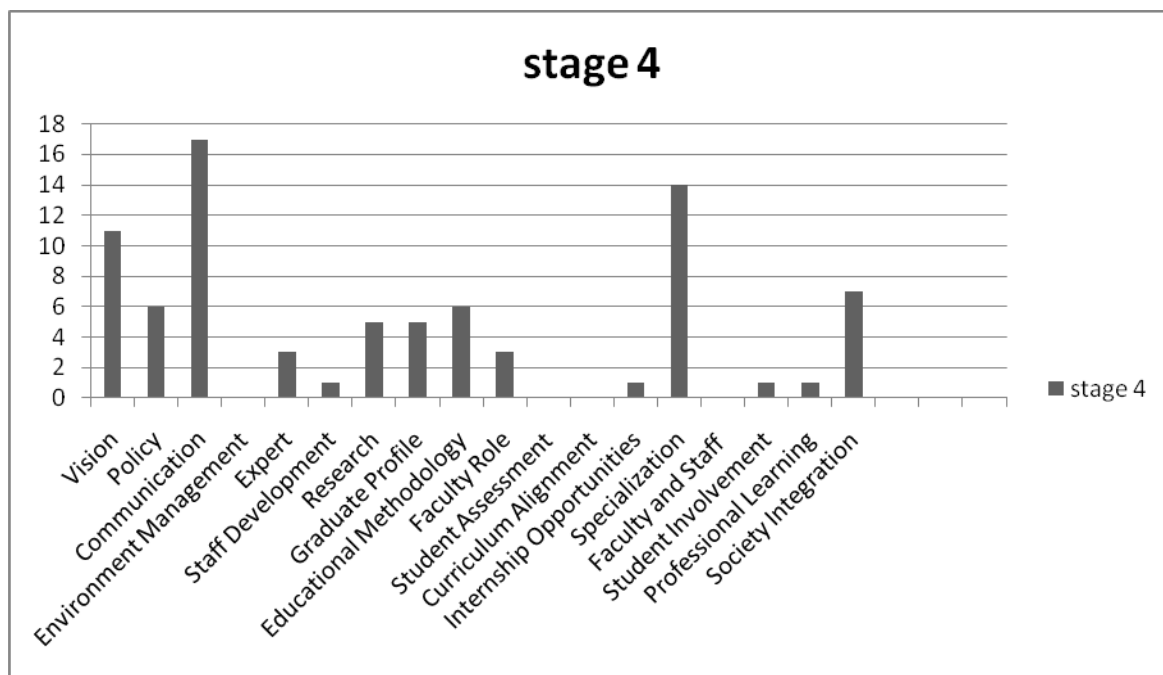


Figure 5. Frequency of higher education institutions at implementation stage 4.

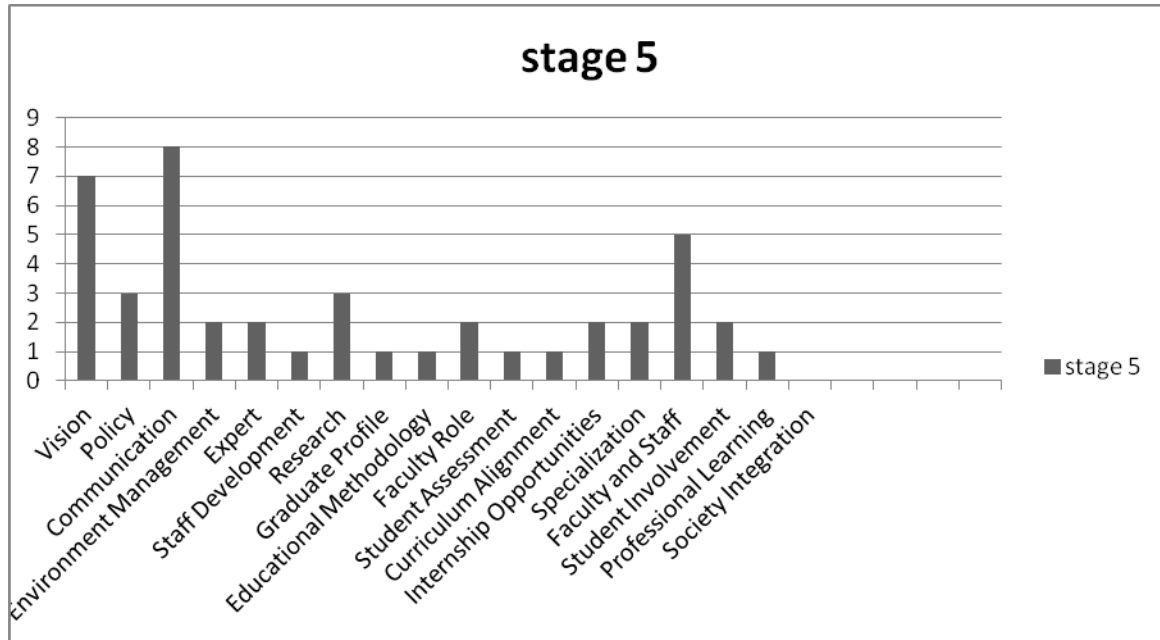


Figure 6. Frequency of higher education institutions at implementation stage 5.

**Proceedings of the 18<sup>th</sup> Annual International Sustainable Development  
Research Conference, University of Hull, Hull, UK, 24 – 26 June 2012; Track 3b**

**Delivering national policy at the local level: The role for local authorities in the  
implementation of the UK's flagship Green Deal policy**

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**Track 3b: The governance of the transition to a low carbon economy/society: What  
roles for public, private and civic actors?**

**Abstract**

The Green Deal (Department of Energy and Climate Change, 2011) is one of the flagship policies of the UK Government's Energy Act (Energy Act c.16, 2011, HM Government, 2011). This Act makes provisions for a step-change in the installation of energy-efficient measures in homes and businesses, which is intended to play a large part in helping the UK Government to meet its legally binding target of an 80% reduction in greenhouse gases (compared with a 1990 baseline) by 2050 and achieve a transition to a low-carbon economy. In this paper we examine the local implementation of this national policy, considering the role for local authorities (LAs) and other local-level actors in its delivery, as well as the challenges and opportunities that are likely to emerge.

The Green Deal will be a market-led scheme that provides a financing mechanism for householders and businesses to install a number of energy-efficient measures and make the repayments on their energy bills, without the need for upfront capital investment. By its nature, the Green Deal will involve delivery at a local level. Local authorities will, therefore, have a significant role to play in the implementation of the Green Deal, but at this stage it is up to each individual authority to decide how it will do this. There are three broad approaches that an LA may adopt: as a provider (directly coordinating finance and delivery), as a partner

working with other providers to facilitate delivery, or as a promoter to advocate the scheme to residents.

From a series of semi-structured interviews with stakeholders in both the public and private sectors across the UK we draw insight into the barriers and opportunities that the Green Deal presents for each. We assess the roles that a local authority could take to enhance uptake of the Green Deal within its administrative area and capture the favourable outcomes that this could offer, such as job creation, economic growth, regeneration of deprived areas, the alleviation of fuel poverty, private-sector investment and increased health and wellbeing for citizens. The approaches and roles we have found being adopted by local authorities in the UK are considered within the frameworks of multi-level governance for energy-efficiency identified in the literature (Jollands et al., 2009, Bulkeley and Kern, 2006).

The work described here builds on previous work conducted by this group (Bale et al., 2012) in which we considered the role for a strategic energy body that would operate under a local authority and provide a strategic vision for the area, facilitating investment and partnerships. Here we identified significant challenges for local authorities implementing national energy policies and provide a caution to the more optimistic view that local government will have a significant impact on energy and carbon reduction. We will, therefore, also consider the benefits a strategic energy body could provide in helping to facilitate local authority involvement in the Green Deal and co-ordinate the range of actors involved in delivering the scheme locally.

We have also conducted related work in developing and applying complex dynamical network models to analyse the implications of behaviour of householders and interactions through the social networks connecting the householders on energy technology uptake (Bale et al., 2011). We have explored the influence that a local authority could have on increasing uptake of a given technology by promoting the sharing of energy information through existing networks. We plan to apply this approach to simulate the implementation of the Green Deal, drawing on consumer data from various sources. Whilst we do not intend to present the modelling work in detail in this paper, we will draw on insights from this work to illustrate examples of how and where local authorities can influence uptake of the Green Deal.

The UK claims international leadership in the arena of energy and climate change policy. This work will contribute to the analysis of whether a flagship UK policy is likely to be able to deliver its objectives. It will draw on the interviews conducted as well as case studies on the UK Green Deal, and lessons from other similar programmes, such as the Property Assessed Clean Energy (PACE) financing programme legislation (which operates in 16 states across in the United States) (2011). This will inform understanding of issues relating to the local implementation of national legislative policy that aims to contribute to a low-carbon transition.

## References

2011. PACE Assessment 5 Protection Act of 2011. *H. R. 2599*. 112<sup>th</sup> Congress 1<sup>st</sup> Session ed.

- BALE, C. S. E., FOXON, T. J., HANNON, M. & GALE, W. F. 2012. Strategic Energy Planning within Local Authorities in the UK: a Study of the City of Leeds. *Energy Policy*, Accepted.
- BALE, C. S. E., MCCULLEN, N. J., FOXON, T. J., RUCKLIDGE, A. M. & GALE, W. F. 2011. Local authority interventions in the domestic sector and the role of social networks: a case study from the city of Leeds. *Energy & People: Futures, complexity and challenges conference*. Oxford: UKERC.
- BULKELEY, H. & KERN, K. 2006. Local Government and the Governing of Climate Change in Germany and the UK. *Urban Studies*, **43**, 2237-2259.
- DEPARTMENT OF ENERGY AND CLIMATE CHANGE 2011. The Green Deal: A summary of the Government's proposals. London.
- ENERGY ACT C.16 2011. London: HMSO.
- HM GOVERNMENT 2011. The Carbon Plan: Delivering our low carbon future. London: The Stationery Office.
- JOLLANDS, N., GASC, E. & PASQUIER, S. 2009. Innovations in Multi-Level Governance for Energy Efficiency. *Energy Efficiency Series*. Paris: International Energy Agency.



**Proceedings of the 18<sup>th</sup> Annual International Sustainable Development Research Conference, University of Hull, Hull, UK, 24 – 26 June 2012;  
Track 3b**

**Track 3b: The governance of the transition to a low carbon economy/society:  
What roles for public, private and civic actors?**

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**Energising communities: the dynamics and governance of everyday domestic practices  
in low-carbon housing**

The way in which our homes are constructed, the household devices with which we interact, and our daily routines account for 32% of total U.K. energy consumption (DECC, 2011) and 27% of total U.K. carbon emissions generated (DTI, 2007). Given the U.K. government's substantial targets of 80% reductions in carbon dioxide emissions by 2050 (DECC, 2008), and for all new homes to be zero carbon from 2016 (DCLG, 2007a), there is an urgent requirement to ensure that new-build homes, as well as our existing homes, are more sustainable both in terms of climate change mitigation and adaptation to a changing climate (DCLG, 2007b). Traditional policy efforts have concentrated upon increasing the rigour of building regulations in order to enhance the energy performance of the built environment; such an approach assumes that occupants play a passive role in reducing domestic energy consumption. Combining mitigation at the household level with policy objectives of additional housing provision has resulted in endorsement of the eco-town concept (DCLG, 2008). These low carbon developments are intended to serve a dual purpose; primarily to act as a means to pilot energy-efficient and renewable technologies, but also to develop understandings of occupant behaviour, culture and consumer-choice, the leverage of policies over which is poorly understood.

Despite a range of efforts employed to curtail the energy utilised by our domestic living arrangements and to minimise the associated carbon implications of this usage, domestic energy demand is continuing to escalate (DECC, 2009; DECC, 2010). This is indicative of the limited effectiveness of current 'techno-economic' (Guy and Shove, 2000) and individualistic 'behavioural change' policy approaches. Our interactions, habits and practices within the home also diverge greatly between individuals and amongst households; occupant energy usage has been shown to vary by as much as 300% to 400% within technically identical houses (Gram-Hanssen, 2004). As such it is essential to go beyond ensuring an energy-efficient envelope for our homes, and the technical efficiency of heating systems and

appliances, to unpack the ways in which we organise our everyday household activities and daily routinized interactions that result in domestic energy consumption and associated carbon emissions.

This research adopts a longitudinal (eighteen month), mixed methods approach in order to analyse occupant interactions within twelve 'zero-carbon' social housing properties, constructed as a pilot for the Rackheath eco-town development (Norfolk, U.K.). These homes are each fitted with the latest green technologies including: super-insulation, triple glazing, an air-source heat pump and under-floor heating system, a mechanical ventilation and heat recovery system and solar photovoltaic panels. In addition, each household has been provided with an energy smart meter and In Home Display (IHD) unit through which members of the household can receive feedback. This research seeks to analyse how, and the extent to which, these low carbon living arrangement and the way in which they are organized and governed, support less energy intensive ways of life. A combination of ethnographic qualitative research, supported by analysis of real time energy monitoring and associated carbon emissions data, will be used to explore how the dynamics of overlapping 'domestic energy consuming practices' contribute to domestic energy consumption (as well as generation). Adopting this approach addresses prior calls for qualitative research methods to be successfully combined with quantitative approaches in order to expand understanding of the social and cultural influences on domestic energy consumption (e.g Crosbie, 2006). Moreover, it is hoped that such an approach will go some way towards tackling the gulf that exists between somewhat abstract sociological research and quantifiable predictions and outcomes that currently inform much environmental policy-making (Shove, 2010).

This research adopts an alternative Social Practice Theory (SPT) lens in order to analyse how, and the extent to which, domestic energy-consuming practices can be renegotiated in a more sustainable direction. Combining the understandings of Gram Hanssen (2008) and Schatzki (1996), in this research, an 'everyday energy-consuming domestic practice' can be defined as a 'temporally unfolding and spatially dispersed nexus of doings and sayings existing in four forms; know-how and embodied habits, institutionalised knowledge and explicit rules, engagements and technologies, the performance of which results in energy consumption'. According to SPT, energy consumption be considered as a 'moment in almost every [domestic] practice' (Warde, 2005, p.137) or as an artefact of carrying out a particular household practice. All practice theories are aligned in the position that 'it is the fact of engagement in the practice, rather than any personal decision about a course of conduct, that explains the nature and process of consumption' (Warde 2005, p.138). Practices are also inherently dynamic across time and are linked across space (Giddens, 1984; Warde, 2005). For this reason, it is not sufficient to conceive of resource consumption merely as demand or as a result of conscious, rational decision-making; instead resource consumption should be analysed on the basis that practices form an integral part of daily life and that resource consumption can result as a consequence of routine, conventional and repetitive conduct. Meeting the challenge of reducing domestic energy consumption, will therefore involve understanding clusters of overlapping everyday practices and either transforming them to

minimise energy use implications, or removing certain unsustainable practices altogether (Hargreaves, 2008).

The research will seek to answer three research questions, considering each in terms of total energy consumption, associated carbon-emissions and household expenditure as well as 'drilling down' to the practice level to explore the implications of the particular practices/conventions of 'doing the laundry' and 'maintaining thermal comfort'. The following three questions seek to address identified gaps in Social Practice Theory and understandings around domestic energy consumption:

Firstly, the interface between particular technologies and the practices that they script and structure have received some attention through studies of the domestication of technologies (Lie and Sørensen, 1996; Silverstone and Hirsch, 1992), which has shown, amongst other outcomes, that users often reinterpret the intentions of designers (Haddon 2006; Brown, 2008). However further research is required, which analyses how new artefacts such as low-carbon technologies and new ideas, influence the emergence, evolution, stability and disintegration of practices (Shove, 2002). In particular Strengers (2009) and Hargreaves, Nye and Burgess (2010) emphasise the need for additional research on the impact of energy monitoring feedback upon domestic energy consuming practices. Further research is also required which engages with the co-evolution of suites of technology and practice and which explores how clusters of practices interact and are horizontally coordinated. As such, this research asks *what role, if any, do low-carbon technologies play in generating, sustaining, modifying or overthrowing everyday energy-consuming domestic practices?* In addition to exploring how occupants are sensitised and adapt to a 'low-carbon home' environment, particular attention will be paid to understanding the interactions between household practitioners and the feedback that they receive from the IHD units.

Secondly, largely to date SPT has provided a de-contextualised picture of practices whereby practices-as-entities are the focus of research as opposed to understanding and analysing practices as routinized and contextualised performances (Schatzki, 1996; Hargreaves, 2008). As such SPT has overlooked how practices interact and affect one another, how combinations of practices are embedded within and become routinized in everyday life, how people come to understand what is required by practices and their role within them, and how different practitioners affect how practices are learnt and undertaken and might stabilise, change or be discarded through social dynamics (Warde, 2005). Although collective conventions and structural aspects form one of the key tenets of SPT, the way in which practices are collectively performed through interactions between individual practitioners has received minimal attention (*cf.* Røpke, 2009; although see Hargreaves, 2011). Further work is required in order to understand how practices are transmitted between individuals (*cf.* Warde, 2005), how they are shared, how they can be collectively negotiated, and how, as well as the extent to which, the lifecycle of practices is influenced by these dynamics. As such this research asks, *what role, if any, do communities of practice* (Wenger, 1998; Lave and Wenger, 1991) *within and between households play in changing (or stabilising) energy-consuming domestic practices?* As practices are distinctly social (Schatzki, 1996), under which circumstances do

people learn to emulate the practices of others, and what processes of social interaction lead to shared understandings and meanings related to energy usage? Does the exchange of perceptions, experiences and tips between low-carbon households lead to variations or similarities in practices? What shared understandings and meanings arise in relation to the repeated or modified performance of particular practices when interacting with new low-carbon technologies? Do influential household members dictate certain ways in which a practice can be undertaken? Here the challenge is to examine how in the context of a neighbourhood of low carbon homes (as well as within a household) communities of practice can influence the lifecycle dynamics of particular domestic energy consuming practices. The possibility exists that by increasing understanding about social learning and interaction with reference to practices, the opportunity to bring about increased sustainability i.e. lower domestic energy consumption, can result.

Finally, as a result of SPT focusing upon practices-as-entities as opposed to considering practices-as-performance (Schatzki, 1996), the role of power relations in the formation and life cycle of practices has been overlooked (Hargreaves, 2008). SPT fails to give attention to whether and how the power dynamic between different groups of people, for instance family relations, programme managers and governing bodies, workplaces or groups of peers, can lead to the control and organisation of practices. In order to bring about a reduction in domestic energy consumption it will be necessary to ‘focus on how groups of practitioners control and discipline one another, how they are in turn controlled and disciplined by the practices they perform, and the implications of these issues for changing practices in pro-environmental directions’ (cf. Foucault, 1977). Given this deficiency, using a reflexive governance approach, this research also seeks to explore how, and the extent to which, formal *energy governance institutions* are actively involved in making and reproducing the systems and arrangements that shape everyday energy-consuming practices within the home.

Reflexive governance acknowledges: (i) heterogeneity of elements – which precludes relying on disciplinary expert knowledge, (ii) uncertainty and feedback – the impossibility of predicting system developments and the effects of interventions, which makes errors unavoidable, and (iii) the irreversibility of social development, which embeds a strong path dependency in decision-making (Voß and Kemp, 2006). Voß and Kemp (2006) highlight how a reflexive governance approach necessarily involves participatory problem definition and goal formation, in an open, experimental and learning oriented environment. As such, they highlight how reflexive governance is geared towards continued learning in light of ongoing developments, rather than towards complete knowledge and maximization of control. Reflexive governance also encourages diversity and pluralism as a means to offer possibilities for renewal and changing practices. This research will therefore seek to understand how energy governance organisations frame the role of the household practitioner (for instance as active or passive; as obedient dupes or as capable of providing insight)? The research will explore whether the aspirations and expectations of energy governance organisations align with those of the household practitioners and the extent to which participatory approaches and concepts of on-going learning are employed in order to promote more sustainable domestic practices.

Although governance organisations can be seen as formalized patterns of rules and decision-making, institutions can be both formal and informal, and are often robust and resistant to change (Gupta *et al.*, 2010). While institutions shape social practices, at the same time those social practices constitute and reproduce institutions (e.g. Giddens, 1984). As such, Schatzki (2001, pp.6, 7) contends that it is social practices that govern both the meanings of arranged entities and the actions that bring particular arrangements about, forming the basis of social order. Taking this a step further, using a Foucauldian analysis of power (i.e. the ‘*how* of power’ – the ways in which power operates through people to create them and sustain the world they experience) (Foucault, 1980, p.92) and drawing upon the concept of governmentality (Foucault, 1991), Hargreaves (2010) develops a critical reading of a particular environmental behaviour change intervention. Following Foucault’s approach of exploring the ‘micro-physics’ of power as it functions throughout society, he examines the micro-political processes of social control such as surveillance, normalization and discipline inherent in a work-place environmental initiative. Following in this vein, given the multiple intersecting arenas in which the governance of domestic energy consuming practices takes place, and the importance of acknowledging the role of power relations and interests in shaping particular practices, this research will also seek to further unpack the micro-politics involved when particular practices are performed at home.

Brown, S. 2008, ‘Household technology adoption, use and impacts: Past, present and future’, *Information Systems Frontiers*, vol.10, pp. 397–402.

Crosbie, T. 2006, ‘Household energy studies: The gap between theory and method’, *Energy and Environment*, vol. 17, no. 5. pp. 735-753

DCLG (Department for Communities and Local Government). 2007a, *Building a greener future: policy statement* The Stationery Office, London.

DCLG (Department for Communities and Local Government). 2007b, *Homes for the future: more affordable, more sustainable* The Stationery Office, London.

DECC (Department of Energy and Climate Change), 2008. “*UK leads world with commitment to cut emissions by 80% by 2050*”. Press Notice ref 2008/3, 16th October 2008 (DECC, London).

DECC (Department of Energy and Climate Change), 2009. “*Energy consumption in the UK: Overall data tables, 2009 update*”, URN 09D/452, July 2009. Available at: <http://www.decc.gov.uk/en/content/cms/statistics/publications/ecuk/ecuk.aspx>

DECC (Department of Energy and Climate Change). 2010, “*UK Climate Change Sustainable Development Indicator: 2009 greenhouse gas emissions, provisional figures and 2008 greenhouse gas emissions, final figures by fuel type and end-user*”, statistical release, 25

March 2010. Available at:

[http://www.decc.gov.uk/en/content/cms/statistics/climate\\_change/gg\\_emissions/uk\\_emissions/2009\\_prov/2009\\_prov.aspx](http://www.decc.gov.uk/en/content/cms/statistics/climate_change/gg_emissions/uk_emissions/2009_prov/2009_prov.aspx)

DECC (Department of Energy and Climate Change). 2011, *Energy consumption in the UK: 2011*. Factsheet based on data from DECC's annual publication "Energy consumption in the UK", July 2011: Available at:

<http://www.decc.gov.uk/en/content/cms/statistics/publications/ecuk/ecuk.aspx>

Department of Trade and Industry (DTI). 2007, *Meeting the energy challenge: A white paper on energy* London: The Stationery Office (TSO).

Foucault, M. 1977, *Discipline and Punish: The Birth of the Prison* (translated by Alan Sheridan) Penguin, London.

Foucault, M. 1980, *Power/Knowledge: Selected interviews and other writings 1972-1977* C. Gordon, ed., Harvester Wheatsheaf, New York.

Foucault, M. 1991, 'Governmentality,' in *The Foucault Effect: Studies in Governmentality*, C. Burchell, C. Gordon, & P. Miller, eds., The University of Chicago Press, Chicago, pp. 87-104.

Giddens, A. 1984, *The Constitution of Society: Outline of the Theory of Structuration*. Polity Press, Cambridge.

Gram-Hanssen, K. 2004, Domestic electricity consumption: Consumers and appliances. In *The ecological economics of consumption*, L. Reisch and I. Røpke eds., Northampton, MA: Edward Elgar

Gram-Hanssen, K. 2008, 'Consuming technologies – developing routines', *Journal of Cleaner Production*, vol. 16, no.11, pp. 1181-1189.

Gupta *et al.* 2010, 'The Adaptive Capacity Wheel: a method to assess the inherent characteristics of institutions to enable the adaptive capacity of society', *Environmental Science & Policy*, vol.13, no.6, pp. 459-471.

Guy, S. & Shove, E. 2000, *A sociology of energy, buildings, and the environment: Constructing knowledge, designing practice*. Routledge, London

Haddon, L. 2006. 'The contribution of domestication research to in-home computing and media consumption', *Information Society*, vol. 22, no. 4, pp. 195–203.

Hargreaves, T. 2008, *Making Pro-Environmental Behaviour Work: An ethnographic case study of practice, process and power in the workplace*. PhD thesis. University of East Anglia, School of Environmental Sciences, October 2008.

Hargreaves, T. 2010, *Putting Foucault to work on the environment: Exploring pro-*

*environmental behaviour change as a form of discipline*, Centre for Social and Economic Research on the Global Environment (CSERGE) working paper, University of East Anglia, ISSN 0967-8875

Hargreaves, T. 2011, *Pro-environmental interaction: Engaging Goffman on pro-environmental behaviour change*, Centre for Social and Economic Research on the Global Environment (CSERGE) working paper, University of East Anglia, ISSN 0967-8875.

Hargreaves, T., M. Nye and J. Burgess, 2010, 'Making energy visible: A qualitative field study of how householders interact with feedback from smart energy monitors', *Energy Policy*, vol. 38, pp. 6111-6119.

Lave, J. and Wenger, E. 1991, *Situated learning: legitimate peripheral participation*. Cambridge University Press, Cambridge.

Lie, M., Sørensen, K. H. Eds. 1996, *Making technology our own: Domesticating technology into everyday life*. Oslo, Scandinavian University Press.

Rip A. 2006. 'A co-evolutionary approach to reflexive governance and its ironies,' in *Reflexive Governance for Sustainable Development*, J. P. Voss, D. Bauknecht, R. Kemp, eds., Edward Elgar, Cheltenham, Glos, pp. 82-100.

Røpke, I. 2009, 'Theories of practice - New inspiration for ecological economic studies on consumption', *Ecological Economics*, vol. 68, pp. 2490-2497.

Schatzki, T. 1996, *Social practices: A Wittgensteinian approach to human activity and the social*. Cambridge University Press, Cambridge.

Schatzki, T. R. 2001, 'Introduction: Practice and theory,' in *The Practice Turn in Contemporary Theory*, T. R. Schatzki, K. Knorr Cetina, & E. Von Savigny, eds., Routledge, London and New York, pp. 6-7.

Shove, E., 2002, 'Converging Conventions of Comfort, Cleanliness and Convenience', published by the Department of Sociology, Lancaster University, Lancaster LA1 4YN, UK, at <http://www.comp.lancs.ac.uk/sociology/papers/Shove-Converging-Conventions.pdf>

Silverstone, R., Hirsch, E. (Eds.), 1992. *Consuming Technologies. Media and Information in Domestic Spaces*. Routledge, London

Strengers, Y. 2009, *Bridging the divide between resource management and everyday life: Smart metering, comfort and cleanliness*. RMIT University. PhD thesis.

Voß, J.P. & Kemp R. 2006, *Sustainability and reflexive governance: introduction*. *Reflexive Governance for Sustainable Development*, eds. J P Voss, D Bauknecht, R Kemp, Edward Elgar, Cheltenham, Glos, pp. 82-100

Warde, A. 2005, 'Consumption and Theories of Practice', *Journal of Consumer Culture*, vol. 5, no. 2, pp. 131-153.

Wenger, E. 1998, *Communities of Practice: Learning, Meaning and Identity*

Cambridge University Press, Cambridge.



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**BIOFUEL PROJECTS AND PARALLEL 'GREEN GOVERNANCE' STRUCTURES  
ON AN ISLAND IN INDONESIA**

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**Abstract**

How green economy concepts become reality depends on grounded processes of green policy implementation and private actors' 'green' activities. From the global scale that sets the discursive context, policies are being translated to the very local scale where a specific variant of green economy is being established. In Indonesia, a variety of state institutions engages in steering parts of the translation process from policy to implementation. This paper analyses the governance structures that have emerged around initiatives for establishing a green economy on an island in Indonesia, either as commercial project, a pilot for renewable energy supply, and part of a national policy for biofuel production. First, the paper discusses how the ways in which 'green economy' is being specified for implementation - focused on low carbon, renewable energy or bio-based economy - affects which type of governance structure is deemed most appropriate. There is a tension between the green economy's comprehensive character, and the reality of implementing specified activities as part of line-Ministries programs. Second, the paper argues that the realization of green economy goals also depends on social dimensions. Currently emerging governance structures merely allow populations in 'upstream production areas' to participate in local tips of global-national policy processes (or private companies commercial activities). More inclusive and socially sustainable governance would position local producers and consumers as leading actors in articulating their own economy with national and global efforts to create green economies.

**1. Introduction**

(included in the full version of this paper)

## 2. Pathways to a green economy

The 'green economy' has been selected as a key organizing theme for the Rio+20 Conference in Brazil in June 2012. While a clear and dominant definition of a 'green economy' has yet to emerge (Okereke and Ehresman 2012), the simplest expression explains a green economy as one which is low carbon, resource efficient and socially inclusive.<sup>1</sup> The first two aspects indicate 'an economy that is environmentally-friendly, sensitive to the need to conserve natural resources, minimizes pollution and emissions that damage the environment in the production process, and produces products and services the existence and consumption of which do not harm the environment' (Khor 2011,1 ). But how can such an economy be realized without constraining social development goals like poverty alleviation and 'enhancing human well-being and social equity' (UNEP 2010)?

### 2.1 Green, low-carbon or bio-based economy

To be able to address these questions the concept needs specification, in focus and context. In the course of ongoing research on the commoditization of a specific biofuel crop (jatropha) in Indonesia we noticed three specifications of 'green economy' : the 'bio-based', the 'low carbon' and the 'renewable energy economy'. Each emphasizes another aspect of green economy, measures progress in a separate set of variables, and each is associated with specific government programs , institutions and legislation. In the developments in the case study analyzed below the three underlying concepts can be clearly recognized.

The 'biobased economy' depicts a future economy in which a large proportion of materials that society needs as consumption goods will be produced from feedstock originating from plants and trees. This transformation of mainly petrochemical ways of industrial production towards the 'biobased economy' requires advanced bio-technology (Paula and Birrer 2006, 255). Industrial biotechnology can decrease the amount of energy and raw materials used to make products and also reduce the amount of emissions and waste produced during production. An example (still partly theoretical) is the crop jatropha cultivated with low external inputs and producing bio-diesel from the oil in the fruits, organic fertilizer from the waste, and protein isolate for feed in fish farming. The ideas of bio-based economy inspired the Indonesian government in 2006 to promote cultivation of biofuel feedstock and set targets for blending biofuel with fossil fuel (Presidential Instruction 1/2006). However, the technologies are not necessarily economically viable and genetic modification techniques meet public resistance (Paula and Birrer 2006, 253).

The 'low carbon economy' is used in Indonesia in a different context. The concept is primarily linked with green house gas (GHG) emissions. It is a specification of green economy that can be measured in terms of reduction of carbon emissions compared with a base line level. GHG emissions in Indonesia amounted to 1.79 gig ton CO<sub>2</sub> in the year 2005, with the major share of emissions coming from land use change and forestry, followed by energy, peat fire related emissions, waste, agriculture and industry (SNC 2010, cited in Thamrin 2011). In response to the world-wide call for action against

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<sup>1</sup> United Nations Environment Programme (UNEP), website 'What is Green economy', Available from : <http://www.unep.org/greeneconomy/AboutGEI/WhatisGEI/tabid/29784/Default.aspx> [accessed 10-4-2012].

climate change Indonesia's President Yudhoyono declared the country's commitment to reduction of emissions at the G-20 summit in Pittsburgh, in 2009. At that summit, the President announced a target for Indonesia of a 26% reduction in GHG emissions below the 'business-as-usual' level by 2020, based on unilateral actions, and a further reduction of up to 41% if adequate international support were made available to the Government of Indonesia (Thamrin 2011, 3). Since 2009 the international support has been mobilized, championed by the 1 billion dollar grant from Norway for REDD activities. The funds are pooled in the Indonesia Climate Change Trust Fund (ICCTF) established by the National Planning Board; the projected resource envelope for 2010-2014 related to the available GHG emissions reduction is around US \$ 4.2 billion (Thamrin 2011,12). However, the conditions to access those funds are strict and complicated, and thus cannot easily be met by local level actors. Moreover, the emission reduction activities are concentrated in forest and peat land, and thus not implemented in other areas. Apart from reducing emissions the 'low carbon economy' in Indonesia also comprises activities for adaptation and resilience that deal with the negative impacts of climate change, and low carbon energy supply and increasing energy efficiency and conservation.<sup>2</sup> Low carbon energy supply is central in activities for replacing fossil fuel by energy from renewable resources. The term 'renewable energy economy' -connecting green energy to a geographical space - is not used widely, though. The 'energy self-sufficient villages' (*desa mandiri energi* (DME)) in Indonesia resemble the concept. Instead, projects focused on increasing use of renewable energy use 'low carbon economy' with emphasis on technologies that foster efficient resource use and decreasing the amount of waste. The measure of success is expressed in percentage of total energy supply that is renewable, and energy saving compared with a base line level. Renewable energy activities can be implemented everywhere, and which area is regarded most suitable depends on the aims of a particular program. One condition is that renewable energy sources (wind, sunshine, land for biomass cultivation or waste) should be available. This interpretation of low carbon economy is also attractive to companies who see opportunities for green business.<sup>3</sup> Moreover, it is a fashionable theme for international development institutions like the Asian Development Bank and the World Bank.<sup>4</sup> The debate about renewable energy in Indonesia is conducted in terms of technology and economics.<sup>5</sup>

## 2.2 The missing social dimension

What the three elaborations of green economy have in common is that they tend to overlook the social dimensions – including social and distributive policies, social relationships and institutions, and the ability of all groups to participate in or contest

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<sup>2</sup> 'Indonesia to develop low carbon economy and contribute to international actions on global warming' The Jakarta Post, 28 November 2011, available from: [http://www.paklim.org/wp-content/uploads/downloads/2011/11/ICCTF-on-Jakarta-Post\\_112811.pdf](http://www.paklim.org/wp-content/uploads/downloads/2011/11/ICCTF-on-Jakarta-Post_112811.pdf) [accessed 10-4-2012].

<sup>3</sup> See for example [www.lowcarboneyconomy.com](http://www.lowcarboneyconomy.com) [accessed 10-4-2012].

<sup>4</sup>See the ADB website on energy, available from: <http://www.adb.org/sectors/energy/main>, and the World Bank website on climate change, available from <http://climatechange.worldbank.org/>, accessed on 10-5-2012.

<sup>5</sup>See the website of the German-Indonesian Renewable energy days in October 2011 that do not mention any social factors. Available from: <http://indonesien.ahk.de/dienstleistungen/wirtschaftsdelegationen/renewable-energy-2011-biomass/> (accessed on 14-5-2012)

policy choices – . The emphasis is on biotechnology development, reduction of green house gas emissions, and replacing fossil fuel with energy produced from renewable resources. However, social dimensions will be critical for successful implementation of those technologies, and thus will be driving the transformation towards a green economy. Following Cook and Smith (2012, 6) we should question ‘whose knowledge counts?’, ‘who has space to act and influence?’, and ‘which practices ultimately drive solutions towards both environmental sustainability and social justice?’ Answering these questions requires empirical research in the specific settings targeted for transformation into a green economy.

In response to the technical supply-side emphasis in research and policy concerning transitions to a green economy, I would like to stress the demand-side. Who will be the consumers in the green economy? Are the characteristics of these consumers assumed or really identified? Is being a consumer limited to those with purchasing power or is anyone living in the area identified as the geographical terrain of a green economy included? These consumption questions bring up issues of scale that indicate the distributional impact of shifts to a green economy. What are criteria for equitable distribution of benefits of a green economy between producers in rural areas and consumers in urban areas, or in other parts of the country or even abroad?

### **2.3 Governmentality and implementation**

Debates on pathways towards a green economy implicitly adopt assumptions about the state and its capacity to steer developments into one of those pathways. However, studies on anthropology of the state have shown that the state cannot be treated as a neutral monolith, but instead could better be understood in a differentiated way as bundles of everyday institutions and forms of rule (Barker and Van Klinken; Corbridge *et al.* 2005; Fuller and Harris 2001). Lower-level public officials reinterpret and sometimes significantly change the practices of government that are handed down to them by national institutions (Corbridge *et al.* 2005, 5). Attention for governmentality - the human technologies of rule (Rose 1999) or the way in which we think about governing others and ourselves (Dean 1999, 209) - points at the complexities of policy implementation in reality. The governmentality linked with the concept of green economy is firmly based in faith that the global problems of climate change and energy supply can be ‘rendered technical’ and solved by expert intervention (Li 2007). An example is specifying the green economy as ‘low carbon economy’, which facilitates implementation but simultaneously simplifies reducing climate change to

..CO<sub>2</sub> molecules (..) comfortably conceptualized as entities without a history, whether human or climatic. As a-political objects seemingly susceptible to manipulation, management and mastery by experts, they are easily treated, fetishistically, as ‘the’ cause of global warming (Lohmann 2012).

Apart from the technologies to reduce GHG emissions, the construct of global carbon markets - including the idea of a low carbon economy - has also created technologies of calculation and administration that have moved far beyond the grounded context to which

they theoretically are linked. Those real contexts are full of contesting interests, making the adoption of new energy technologies a fuzzy and unpredictable process.

### 3. Green economy governance in Indonesia

In contrast to UNEP's seminal report *Towards a Green Economy* which discusses the subject of governance in one of the last chapters, as one of the 'enabling conditions' for the technical innovations that the transition to a low-carbon economy requires (UNEP 2011, 546-81), this paper argues that governance is a crucial factor for successful realization of a green economy. 'Governance' - whether at the grassroots or global levels - encompasses the activities of governments, but it also includes the many other channels through which "commands" flow in the form of goals framed, directives issued, and policies pursued (Rosenau 1995, 14). For this paper I define green economy governance as the way in which both state and private actors initiate, plan, propose, negotiate and decide about activities that contribute to achieving one or more goals of the green economy they engage themselves with, and how they collaborate with each other. The emerging governance structures refer to the links through which these actors organize their relationship for performing governance, either in a top-down fashion or by some form of sharing power.

#### 3.1 Hierarchies or networks

In the bureaucratic tradition of Indonesia before 1998, when the national government institutions were still in charge and could order their subordinates, governance was hierarchical. One example here is the policy on reduction of GHG emissions, that commenced with the President's declaration at the international conference and the following elaborate planning process from national to district level. However, times have changed in Indonesia and since 2001 the national government has devolved many powers to the district governments, of which there are more than 400 in the country. After regime change in 1998, the style of governance changed from command and control to 'enabling', establishing the regulatory framework for environmental management and investment (among other things), using partnerships, negotiation and persuasion (McCarthy 2010, 100). Theoretically, under decentralization, 'subsidiarity' would be a useful principle to apply in considering governance at different levels, which states that matters ought to be handled by the smallest, lowest or least centralized competent authority (UNCSD 2011). However, local governments cannot violate national or regional legislation, and they are dependent to varying degrees on higher levels of government for funding, and have limited legislative powers (UNCSD 2011, 4).

When the relevant authorities concerning core activities for a comprehensive policy goal are not concentrated in one hand - as in the case of a green economy - stakeholders can apply "networked governance" for making decisions and taking actions while sharing power and responsibility beyond state actors alone (Creech 2008,1). In Indonesia, the 'task force' is a common structure for networked governance. Its legal status can vary from informal up to being installed by presidential decree. In the pilot-green economy that will be discussed below a group of main stakeholders have composed a task force at

the initiative of an international NGO, the Ministry of ESDM and the district government.

A third type of governance besides the 'hierarchical' and 'networked' in which state institutions are the dominant actors, is the governance of 'the market' in which private actors in their role of suppliers and consumers are the main actors. However, the neo-liberal free market model is highly theoretical when applied to questions of green economy in Indonesia, because the market is regulated in many ways and prices are being influenced by subsidies. Appropriately acknowledging the interaction between state and private actors the 'market governance' for a green economy can be regarded as a type of networked governance in which big companies are the most powerful actors, as in the sugar cane case discussed below.

The governance structures - whether hierarchical or networks - for a green economy can be compared by studying their successes in achieving the (quantitative) goals of the policies they implement. A more comprehensive assessment - including the social dimensions - should additionally focus on issues of inclusion, participation and power sharing, strategic influence, clear definition of purpose and roles, and accountability (Malena *et.al* 2004).

### **3.2 Government actors**

If we take a real implemented case of 'green economy' in mind, there are many participating actors. The governance structure comprises local government institutions, but also includes the vertically linked Ministries and their regional branch offices. In general, the tension about legal authority within the administrative system is at a horizontal level between the various departments (for example: is cultivation energy crops an issue for the Energy Department or for the Agricultural Service?). Vertically there is a tension between the levels of government - national, provincial or district - for example when a national policy stimulates energy crop cultivation, but the implementation depends on whether plantation companies obtain permits to access land from the local level governments. The lack of coherence (between vertical lines) and integration (between horizontal levels) of governance and legislation in Indonesia is notorious (Otto...; Moeliono 2011, McCarthy 2011). However, if we consider not only the formal authority to take decisions, but include decision making power connected to the funding capital the picture of governance structures becomes even more complicated. In response to the lack of coherence between ministries, a new governance structure has been set up in December 2009: the President's Unit for Development Supervision and Control (UKP4). Its task is to monitor and verify the delivery of state services with the help of engaged citizens and to break bottlenecks among ministries. UKP4's chairman Mangkusubroto is the former energy and mining minister who led Indonesia's recovery after the 2004 tsunami, and the unit reports directly to the office of the vice president. The UKP4 establishes 'task forces' for issues that require immediate policy coordinated policy attention; for example for coordinating the National REDD+ strategy that followed up the Presidents' commitment to reduce GHG emissions. However, other 'green economy' programs are not directly coordinated by such a high level governance unit. However, the model of establishing a 'task force' is also seen as solution for governance of complicated processes that require input and commitment of multiple stakeholders.



Some 'green economy' task forces have been initiated by directorate general for managing renewable energy and energy conservation, which was established in 2010 by the Ministry of Energy and Mineral Resources.<sup>6</sup> Within that Ministry the renewable energy directorate is very small in terms of budget and present economic interests when compared with the long established directorates for mining and gas and oil exploitation. However, the ambitions are high with the 'Energy Vision 25/25', whereby the Indonesian government aims for renewable energy utilization to contribute 25 percent of national energy consumption in the year 2025.<sup>7</sup>

From the national scene we now jump to the ground on the island Sumba, where other state actors seem much more involved in governing a green economy than the institutions mentioned so far.

#### **4. Sumba's green economy**

Sumba is an island in the eastern part of Indonesia.<sup>8</sup> Up to the early 1990s, Sumba had 'low carbon economy', but that was the result of poverty rather than intended policies (Vel 1994). Levels of health, nutrition, and life expectance were low, and public services hardly existed, for example no public transport, and electricity only in the main towns. It was not a 'green economy' to be romanticized, but people had enough land to grow their food crops and graze their livestock, and they could access the forests for gathering building materials, firewood, and food in times of shortage. This situation has been changing rapidly since then.

The island's land surface is 11,000 km<sup>2</sup> - a third of the Netherlands' size - and it has various climatic zones. The hilly interior is green with annual rainfall over 2000 mm, whereas the northern and eastern coastal planes are very dry. The dry and inaccessible areas are very sparsely populated. Most people used to live in hill top settlements in areas suitable for agriculture, but as the roads became better and towns developed as education and government centers, many moved to the roadsides and towns. In 2010, Sumba had around 700,000 inhabitants.

Regional Autonomy (Law 25/1999) brought a new situation of relative freedom, local accountability and larger budgets to the district governments (Vel 2008). Previously, during the 32 years of Suharto's authoritarian regime, the government had been structured firmly top-down, with appointed district heads loyal to their superiors outside the island. From 2004 onwards district heads are elected directly by their local constituencies. The regional autonomy process included the option of splitting up districts. In 2007, the former West Sumba was split in three new districts, forming administrative units that coincided better with clan territories and, more importantly, opening the opportunity for receiving more government budget from the national government in Jakarta than what the undivided West Sumba would have received. The new district governments, eager to

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<sup>6</sup> <http://www.thejakartapost.com/news/2010/08/25/govt-establishes-renewable-energy-directorate-general.html> (accessed on 14-5-2012).

<sup>7</sup> Following the 25/25 rally for America's energy future that was initiated in 2004. See: <http://www.25x25.org/> (accessed on 14-4-2012).

<sup>8</sup> The author of this paper lived and worked in Sumba for 6 years in the 1980s.

develop their economies, try to attract private investment, advertising agriculture, mining and tourism. Many private companies are exploring business opportunities in Sumba.

The next three developments since 2006 described below contribute to establishing a modern style green economy in Sumba. Each narrative contains a specific perspective on the island, includes a set of main actors and has its own link with the transition to a green economy.

#### 4.1 *Jatropha* for biodiesel

In 2006, the Indonesian President issued a decree for development of biofuels, which corresponds with the ideal of a bio-based economy. The policy's regional roadmaps indicated Sumba as a suitable area for cultivating *jatropha curcas*, a perennial shrub with oily nuts that can be processed into biodiesel. World-wide the claims about this crop were amazing: allegedly, it could grow on marginal lands, would not need much water, would bring rural employment opportunities and alleviate poverty (Jongschaap *et al.* 2007). The Ministry of Agriculture promoted cultivation in the whole country, with every district's Agricultural Service supplying seeds, knowledge about cultivation practices and small amounts of money ('incentives') for farmers who planted the crop on their lands. Unfortunately, there was no market demand once the farmers harvested the first *jatropha* fruits (Vel 2008a). In hindsight, the Head of Agricultural Services in Central Sumba explained that marketing the produce had been regarded as a matter for the Industry and Trade Service. However, that Service was more involved in developing tourism rather than organizing the value chain for agricultural commodities.<sup>9</sup> In 2006 a staff member of the state-owned electricity company PLN had tried to organize a *jatropha* chain. He had mobilized a group of farmers willing to grow *jatropha* and supply the fruits for use as feedstock for the PLN's electricity generators that up to that time completely rely on fossil fuel (diesel). However, the trial failed when the economically competitive price offered to farmers was too low to motivate them for further cultivation. The maximum price he could offer farmers was based on the - heavily subsidized - price of fossil diesel. The politically sensitive fuel subsidy policy can only be changed at the national level. Farmers preferred growing a cash crop with a higher price and a good revenue in relation to the amount of labour they would invest in cultivation and post harvest work (Vel and Nugrohowardhani 2012).

Since 2007 there are no more government *jatropha* programs, but instead private domestic companies appeared in Sumba with proposals to establish large *jatropha* plantations. They submitted their business proposals to the district government for obtaining a location permit, which functions as license to develop the land, and as asset for the company to attract (foreign) investors. In the short term the business of the domestic brokers companies thrived on selling services for exploratory studies, writing proposals and obtaining legal permits to investors who lack this local knowledge. District governments lack sufficient objective information that would be required to assess the proposals well, and there is little island-wide exchange of information among officials of adjacent districts. The provincial Planning Board Bappeda could act as coordinating institution, but spontaneous activities of private companies do not always correspond with government planning. And after all, the district governments are autonomous in deciding about granting permits to companies. Lack of coherence between vertical

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<sup>9</sup> Interview in October 2011, Waibakul, Sumba.



ministry lines and coordination between districts contributed to failing implementation of this particular policy for growing energy crops. A similar dilemma to find the appropriate scales of governance institutions for furthering a green economy is found in the next initiative, to make Sumba an example for renewable energy programs.

#### **4.2 Iconic Island for renewable energy**

By the end on 2010, Hivos (a Dutch NGO) launched a new program for stimulating the use of renewable energy. The NGO searched for a bounded area where a 'green economy' could be established that could serve as an inspiring example for people in other parts of the world. The goal of the program as:

Providing the population of a medium sized Indonesian island with 100 percent renewable energy. Improving the quality of life for hundreds of thousands of people in small island communities. Stimulating economic development as well as taking concrete steps towards addressing climate change.<sup>10</sup>

The choice for Sumba was made in collaboration with the Indonesian Ministry of Energy and Mineral resources (ESDM) and the national Planning Board (BAPPENAS)<sup>11</sup>. The main considerations concerned the availability of renewable energy sources (wind, hydro, solar, biomass, biogas and geothermal energy), the very low electrification ratio, and the local electricity company (PLN)'s support for renewable energy (Winrock 2010, 77-8). Hivos signed a memorandum of understanding with the governments and parliaments of Sumba's four districts, and the Governor of the province NTT that overarches the districts, and with the PLN. In initial meetings in Sumba about the implementation of renewable energy the PLN and the District Service for Energy and Mineral Resources were the NGO's most important discussion partners. However, for the development of energy crop cultivation the Agriculture and Plantation Service are the important government institutions. The latter department's priorities are still - in spite of regional autonomy - highly influenced by national and provincial policies of their Ministry, not in the least because the vertical structure of the Ministries makes district agriculture and plantation service the district level institution for spending national budgets. Responding to Ministries' and the state-owned companies' vertical structure for internal governance, Hivos has been communicating and collaborating with the government officials in these organizations at national and provincial level. In March 2012 the Ministry of Energy and Mineral Resources, in collaboration with the Provincial Government, the government of Sumba Barat Daya district, the Bank BNI and PLN branches in this district, the Board for promotion and application of technology (BPPT), PT Sumberdaya Sewatama (Indonesia's leading power solutions provider company) and Hivos, organized a meeting in Sumba to discuss the formation of the Task Force Sumba Iconic Island 2012-2025 and a road map for renewable energy development on the island.<sup>12</sup> The short reports about

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<sup>10</sup> Hivos website

<sup>11</sup> 'Sumba Sebagai Pulau Energi Terbarukan' on website Ministry ESDM, 22 March 2012, Available from: <http://www.ebtke.esdm.go.id/berita/535-sumba-sebagai-pulau-ikonis-energi-terbarukan.html>

<sup>12</sup> 'Pelihara Sapi Panen Energi Terbarukan' Portal Indonesia 19-3-2012. Available from: <http://www.indonesia.go.id/en/regional-government/east-nusa-tenggara-province/2178.html> and <http://www.sergapntt.com/2012/03/orang-sumba-pelihara-sapi-panen-energi.html> [accessed 5 -4 2012].

this meeting reveal how the stakeholders included in the meeting insert their institutions' agendas in the shared plan for the 'Iconic Island'. For example, the director bio-energy of the Ministry ESDM mentioned that for this Ministry Sumba is a pilot project for renewable energy development, whereas the vice governor of the Province NTT urged to harmonize this energy project with the goals set in the government's regional development plans.<sup>13</sup>

The task force is a new emerging governance structure for a green economy, and an example of state led networked governance. However, without a strong voice of local actors it runs the risk of becoming a forum for discussing government energy policies, without social dimensions.

### 4.3 Sugar and electricity

Completely parallel to the renewable energy initiative, a big agribusiness company was initiating a 25,000 hectare sugar plantation in the western part of Sumba, and a sugar factory. The plantation plans started in 2011, when the company's quest for land in Indonesia brought it to Sumba. PT Wilmar is Asia's leading agribusiness group with headquarters in Singapore, with operations in more than 20 countries, over 80,000 employees, and an integrated agribusiness model that captures the entire value chain from origination and processing to the branding, merchandising and distribution of a wide range of agricultural products.<sup>14</sup> The company organized a trip for 70 important stakeholders from Sumba Barat Daya to visit its plantation and factories in Lampung. A smaller group, including the district head and the main heads of services and departments, were invited to Australia to visit the factory's activities there. These trips convinced the district officials that the company was really serious. The national government supports this development because it aims to expand the country's sugar cultivation with at least 500,000 hectares of new plantations until 2014 when the country is to achieve self sufficiency in sugar supply. The national government designed several support measures: simplifying the process of securing land rights, preparing infrastructure for sugar plantations, and offering tax incentives and subsidy on credit interest to increase investment in sugar sector (ICN 2010).

Sugar cane cultivation is important for renewable energy production, because of its enormous scale, and its potential to produce feedstock for electricity production. Processing factories produce sugar, ethanol and bagasse as waste product. Australian company technicians estimated that the factory planned in Sumba could deliver up to 30 Megawatt to the PLN electricity grid, which is more than threefold the current capacity of the electricity grid in West Sumba. Proponents of the plantation plans argue that it will bring prosperity to the population: employment, electricity, services and a compensation for their land. However, the assumptions seem overly optimistic and a negative impact on local food security is likely (Vel and Nugrohowardhani 2012). From the point of view of the company the feasibility of supplying to the PLN does not depend on plans for transition towards a green economy, but on the local price for electricity per KW hour. In October 2011, there had not been any discussion yet between the government, company and PLN about this option for electricity production. The governance structure in this case was 'corporate governance' in a market environment that is strongly influenced by

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<sup>13</sup> <http://sergapntt.wordpress.com/2012/03/15/orang-sumba-pelihara-sapi-panen-energi/>

<sup>14</sup> Source: [http://www.wilmarinternational.com/news/press\\_releases/Wilmar\\_SGXNet\\_press\\_release\\_05072010.pdf](http://www.wilmarinternational.com/news/press_releases/Wilmar_SGXNet_press_release_05072010.pdf)

national government policy. The local government was only involved for providing access to land.

## **5. Social accountability**

The three developments discussed above all contribute to a green economy, at least in theory. However, the currently emerging governance structures in this case at best allow populations in 'upstream production areas' to participate in local tips of global-national policy processes or private companies commercial activities. More inclusive and socially accountable governance would position local producers and consumers as leading actors in articulating their own economy with national and global efforts to create green economies. In the current governance structures local voices are not well-represented, neither as producers of energy feedstock nor as energy consumers.

A focus on energy-consumers inserts the perspective of real existing demand in the discussion about energy transitions. In general, the bulk of energy consumption is concentrated in urban (more densely populated) areas and in industrial zones. In Sumba this means a spatial division that concentrates the top (but still low) energy users in the capital towns of the districts and along the main roads connecting those towns. The electricity grid is organized likewise: in town and along the main roads. Consumers there have access to electricity and depending on the service they can use all kinds of electronic equipment. Increasing numbers of town-and-main-road dwellers have a motor cycle and buy petrol as fuel. At the opposite end of the spectrum are the poorest families who live far off the road in the hills in their garden houses. They do not use much energy, just light a kerosene lamp and use firewood for cooking. In between these categories are the people living close to minor roads who have a solar panel that provides energy for lamps and for a radio. For each of these categories of consumers the issues related to energy are different. The electricity company PLN and the oil company Pertamina provide services to the 'urban' category, and both companies in Sumba constitute district branches of a national state owned company. When planning for a transition to a green economy it makes a big difference whether the end consumers are the upland people off the road, or the 'institutional consumers' PLN and Pertamina who aim at using more renewable sources for their energy production. For the upland poor the energy issue is to increase access to any type of energy (which is a product of availability and ability to buy or receive it). Climbing up the 'energy ladder' to more sustainable energy systems is difficult where there is no energy access to begin with. The top priority in interventions for poverty alleviation should be to ensure that the poor are given access to energy services before they are asked to 'leapfrog' to more sustainable energy options (McDade *et al.* 2006 ,218). However, attention in biofuel and renewable energy programs is concentrated on reaching targets for substituting fossil energy with renewable energy, for example by building a big windmill for electricity generation, to replace diesel generators. If poverty alleviation is a serious goal of intervention, activities should be preceded with analysis of the causes of poverty in the area of concern, instead of assuming that 'energy is the key to development'. Field research in October 2011 in Sumba indicated that the poorer part of the population was most concerned with finding solutions for shortage of food, water and money. They did not perceive "energy" as an urgent issue.

Such a gap between program objectives and people's perceptions and priorities could be overcome if governance of transitions to a green economy would be participatory and socially accountable (Malena et. al 2004). In a participatory governance process citizens influence and share control in processes of public decision making that affect their lives (Malena 2009:7). The goal is to ensure an equitable representation of different interests and societal groups, especially of disadvantaged or marginalized groups, in those decisions and processes that most directly affect people's lives. (Malena 2009, 8). For the case in Sumba, a more prominent role of the four District Parliaments and local NGOs in decisions making concerning establishing large plantations or renewable energy generating facilities. To be able to perform that role it is crucial that these local actors who represent citizens have sufficient objective information, for free, prior and informed consent (Colchester and Ferrari 2007).

## References

- Cook, S. and K. Smith. 2012. Introduction: Green economy and sustainable development: bringing back the 'social'. *Development* 55 (1) 5-9.
- Colchester, M. and Maurizio Farhan Ferrari, 2007. Making FPIC Work: Challenges and Prospects for Indigenous Peoples. Forest Peoples Programme, Moreton-in-Marsh.
- Corbridge, Stuart, Glyn Williams, René Veron and Manoj Srivastava, 2005. *Seeing the State: Governance and governmentality in India*. Cambridge: Cambridge University Press.
- Creech, H. 2008. The Governance of Non-Legal Entities: An exploration into the challenges facing collaborative, multi-stakeholder enterprises that are hosted by institutions. Winnipeg: International Institute for Sustainable Development.
- Dean, M. 1999. *Governmentality: Power and rule in modern society*. London: Sage.
- ICN (Indonesian Commercial Newsletter) 2010. Development of sugar plantations toward sugar self sufficiency. (Industry profile).
- Jongschaap et al. 2007. *Claims and Facts on *Jatropha curcas* L.* Wageningen: WUR PRI.
- Klinken, G van, and J. Barker (eds), 2009. *State of authority: the state in society in Indonesia*. Ithaca: Cornell Southeast Asia Program Publications.
- Kohr Risks and uses of the Green economy concept in the context of sustainable development, poverty and equity.
- Li, Tania Murray 2007. *The will to improve: governmentality, development and the practice of politics*. Durham: Duke University Press.
- Lino, Paula and Frans Birrer 2006. Including public perspectives in industrial biotechnology and the biobased economy, *Journal of Agricultural and Environmental Ethics* 19:253–267.
- Lohmann, L 2012 Financialization, Commodification and Carbon: The Contradictions of Neoliberal Climate Policy. *Socialist Register* 48.
- Malena, C., R. Forster, and J. Singh. 2004. *Social Accountability: An Introduction to the Concept and Emerging Practice*. Washington D.C.: World Bank
- Maxwell and Adam Schwarz 2012. 'How Indonesia hears the voice of the people'. *McKinsey Quarterly*, February 2012.

- McCarthy, John F. 2011. 'The Limits of Legality: Governance, Extra-legality and Resource Control in Indonesia' in G.van Klinken and E. Aspinall (eds) *The State and Illegality in Indonesia*, Leiden: KITLV Press.
- McDade, S., M. Takada, and J. Porcaro, 2006. Putting development first: the role of renewable energy in achieving the MDGs, in D. Assman, U. Laumanns and D.Uh (eds) *Renewable Energy: a global review of technologies, policies and markets*, London: Earthscan. 217-29.
- Rosenau, James N. 1995. Governance in the Twenty-first Century. *Global Governance. A Review of Multilateralism and International Organizations* 1 (1): 13-43
- UNEP (United Nations Environment Program) 2010
- UNEP, 2011, *Towards a Green Economy: Pathways to Sustainable Development and Poverty Eradication*, Available from: [www.unep.org/greeneconomy](http://www.unep.org/greeneconomy)
- UNCSD 2011. 'Regional, national and local level governance for sustainable development', Rio+20 Issues Briefs no.10.
- SNC 2010. Indonesia Second National Communication Under The United Nations Framework Convention on Climate Change (UNFCCC).
- Thamrin, Syamsidar. 2011. 'Indonesia's National Mitigation Actions: Paving the Way towards NAMAs'. Discussion Paper Bappenas Indonesia. Paris: CCXG/Global Forum on Environment Seminar on MRV and Carbon Markets
- Vel J.A.C. 1994 *The Uma-economy: indigenous economics and development work in Lawonda, Sumba, Eastern Indonesia*. Wageningen: Wageningen University and Research.
- Vel, J.A.C. 2008a. Miracle crop or Imminent Disaster? *Inside Indonesia* 91.
- Vel 2008a *Uma Politics; and ethnography of democratization in West Sumba 1982-2006*. Leiden: KITLV Press.
- Vel and Nugrohowardhani 2012. Plants for Power; the potential for cultivating crops as feedstock for energy production in Sumba. The Hague: Hivos.
- Winrock 2010. 'Fuel-independent renewable energy 'Iconic Island'; preliminary resource assessment Sumba and Buru islands, Indonesia'. The Hague: Hivos.

## **Proceedings of the 18<sup>th</sup> Annual International Sustainable Development Research Conference, University of Hull, Hull, UK, 24 – 26 June 2012; Track 3c**

Track 3c: Public Participation

### **Participation and transformative sustainable development**

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Recent debates on sustainable development increasingly shift the focus from the technocratic and economic fix of environmental problems to more fundamental changes in socio-political processes and relations. We can witness this shift not only in scholarly debates but also in international agendas, such as ones in this year's United Nations' Rio+20 Conference promoting green economy for sustainable development. Experts discuss that green economy is not simply about linking economy to environment but requires a deeper restructuring of governance and reshaping of institutional arrangements for funding and resource mobilization (e.g. LeBlanc 2011; United Nations Research Institute for Social Development 2011; Harcourt 2012). In these discussions, 'participation' is drawing renewed experts' attention, as it is resituated from an externally elaborated technical approach to possibly 'a legitimate and genuinely transformative approach to development' (Hicky and Mohan 2004: 3), which needs to be linked to 'good governance more broadly' (Cleaver 2007: 225, see also Otsuki 2012: 200).

Then a question arises: How do we, the development experts, know if a participatory development project is transformative within the context of the existing forms of governance and if the transformation is sustainable? The experts conventionally come up with logical frameworks, which list various indicators to measure 'transformation' and 'sustainability' with reference to the 'common goal' of sustainable social transformation set up by a group of stakeholders. These logical frameworks also predetermine a timeframe to induce the desired transformation.

This paper argues that we need to rethink this entire logical set up, as transformative development is essentially a processual concept, which cannot assume a priori a common goal and an expected timeframe. In order to know if the development is transformative and the transformation sustainable and what kind of policy implications for the potentially sustainable transformation we can draw from the development outcomes, we first need to be more

carefully accompanying the process of the participants' (and non-participants') learning by (not-)participating, manifested in both 'successful' and 'failed' participatory development projects.

### **Reflexivity-based framework and participation**

Using insights from social theory and anthropology, this paper proposes a reflexivity-based framework to analyse participation as a type of social action, which has become routine action in the participants' lifeworlds. According to Archer (2007), routine action is underpinned by primary experience, which can have a transformative effect if the participants are allowed to reflect on the experience, share the reflection with others through collective deliberation embracing the 'secondary experience' (Reed 1996), and open new spaces for change.

By going through the dialectic process of participation, reflection, and change, the participants learn to evaluate if the transformation is fair and just to their lifeworld, and through this evaluation they view their lifeworld as embedded in the larger context of governance. The participants are then able to relate themselves to resource gatekeepers in order to bring about a progress in reshaping the existing institutional forms of governance and effectively claiming state engagement (Otsuki 2012).

Theoretically, the reflexivity-based framework aims to demystify the Cartesian rationality of project participants who are supposed to carefully plan to participate in achieving a common goal with a clear intention of transforming their society. This rationality is based on a myth of 'cultural integration', which automatically works to connect a rational individual to his or her (imagined) society and living environment. In this myth, individuals are not supposed to reflect on themselves and their relations to the collective (Archer 1985; 2007). As the anthropologist Milton (2002) has also discussed, the lack of attention to reflexivity in conventional social analysis of environmentalism limits our understanding of an emotional mechanism through which we keep on relating ourselves to natural environment. These arguments show that we need to redefine human agency from a capability to make a purposeful change to more pragmatic capability underpinned by primary sense experience of routine action, including participation, and emotion whose contingency may turn out to induce change. This also means that we need to redefine individual participants as corporeal citizens with autonomous subjectivity who are embedded within the particular political and ecological environment and simultaneously shape the environment in an open world (Ingold 2011).

In practice, the reflexivity-based framework situates any kind of development projects within each participant's life history and examines the logical framework of the projects with reference to ways that the participant reflects on the participation experience. This means that development projects always trigger a process of learning even if they are considered to have 'failed'. Civic engagement with development is nurtured in the learning process, and it is therefore vital for development experts, especially the planners envisioning social

transformation, to recognise the emergence of deliberative spaces in which the project participants determine relevance of the planning to own changing environment.

### **Re-evaluating community participation: cases from Brazil and Kenya**

The paper applies the framework to re-evaluate the 'failed' community-based projects in Brazil and Kenya during the 1990s-2000s and shows how the community participation in sustainable development projects (community-based forest management in Brazil and community-based sanitation in Kenya) became irrelevant to the community members' individual life projects, as the members reflected on the participation experience and redirected their action. The case study shows that the community-based project participants' redirection of action to identify new spaces for change could have been institutionalised to strengthen local governance vis-à-vis civil society organisations, state agencies, and private businesses. The stronger local governance is discussed as a key institutional set-up to fruitfully connect individual participants as citizens who claim their own spaces for change through the implementation of community-based environmental management.

The paper concludes by asserting that social transformation cannot be planned beforehand but the conditions for it appear from any project process, with reference to, but outside the pre-determined logical frameworks. Institutionalising the transformation to reshape governance needs to recognise the newly emerging conditions by which the participants can keep on defining own terms of engagement with sustainable development.

### **References**

- Archer, M. (1985) 'The Myth of Cultural Integration', *The British Journal of Sociology* 36(3): 333-353.
- Archer, M. (2007) *Making Our Way Through the World: Human Reflexivity and Social Mobility*. Cambridge: Cambridge University Press.
- Cleaver, F. (2007) 'Understanding Agency in Collective Action', *Journal of Human Development and Capabilities* 3(2): 223-244.
- Harcourt, W. (2012) 'Editorial: The Times They are A-Changin'', *Development* 55(1): 1-4.
- Hicky, S. and Mohan, G. (2004) *Participation: From Tyranny to Transformation? Exploring New Approaches to Participation in Development*. London: Zed Books.
- Ingold, T. (2011) *Being Alive: Essays on Knowledge, Movement, and Description*. London: Routledge.
- LeBlanc, D. (2011) 'Special Issue on Green Economy and Sustainable Development', *Natural Resources Forum* 35(3): 151-154.
- Milton, K. (2002) *Loving Nautre: Towards an Ecology of Emotion*. London: Routledge.



Otsuki, K. (2012) 'Reflexivity in Participatory Development: Framing Community-Based Natural Resource Management on the Amazon Frontier', *Human Organization* 71(2): 200-210.

Reed, E. (1996) *The Necessity of Experience*. New Haven: Yale University Press.

United Nations Research Institute for Social Development (2011) Green Economy and Sustainable Development: Bringing Back the Social, background paper to United Nations Conference on Sustainable Development available at:

[http://www.unrisd.org/80256B42004CCC77/%28httpInfoFiles%29/44AC8E087556E45AC125793D0056E4B7/\\$file/UNCSD%20input\\_UNRISD.pdf](http://www.unrisd.org/80256B42004CCC77/%28httpInfoFiles%29/44AC8E087556E45AC125793D0056E4B7/$file/UNCSD%20input_UNRISD.pdf)

**Proceedings of the 18<sup>th</sup> Annual International Sustainable Development  
Research Conference, University of Hull, Hull, UK, 24 – 26 June 2012; Track 3d**

**Responsible Leadership for Genuinely Sustainable Development**

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I have been asked to write a book *Responsible Leadership in Business, Politics, Arts and Science*. Responsible leaders look after the sustainable wellbeing of humans and nature – both current and future generations. Responsible leaders take over the reins of threatening situations and serve as models for others. Responsible leaders pull others with them to higher ethical levels of behaviour and enable environmentally socially, culturally and economically sustainable development.

Politicians have failed to show responsible leadership at yet another UN Climate Change Conference and once again prioritized environmentally unsustainable business run by irresponsible leaders over the future of humankind and other species on this planet. Social unsustainability is equally rife: even the UN Millennium Goal of eradicating extreme poverty and hunger by 2015 will not be met. Global bottom-up initiatives like the Occupy movement and Greenpeace fight socio-economic and ecological injustice, respectively, and could be supplemented by novel top-down approaches. There is an urgent need to gather the genuinely responsible leaders from all walks of life together to help the young to turn their catastrophic legacy from us into a hopeful future by creating a new world order of Genuinely Sustainable Development, in which economic sustainability is just a means to reach environmental and sociocultural sustainability.

In Genuinely Sustainable Development environmental sustainability can be achieved by staying within the limits of the carrying capacity of the ecosystems and by revitalizing the ecosystems through protecting their biodiversity and their life-support systems. Sociocultural sustainability can be attained by staying within the limits of the carrying capacity of humans and cultures, and by revitalizing human and cultural diversity and their life-support systems. Economic sustainability can be achieved by staying within the limits of the financial resources and global, regional and local legal and ethical norms, and advancing them, so that an environmentally and socio-culturally good life can be supported both now and in the future.

In my search for responsible leaders I came across work done by Dame Kiri Te Kanawa for young talented singers during the past twelve years. She cannot be called a holistically responsible leader as she is mainly interested in the cultural sustainability of classical music and her travelling life-style is environmentally unsustainable. However, Dame Kiri has built a network of organizations in order to detect and nurture talented classical singers to help to secure the future of classical music that could be replicated and applied to detect and nurture talented young for responsible leadership to help to secure the future of this planet. Dame Kiri's work is centred on her foundations and her roles in other organizations serve the mission of these foundations:

1. Master-classes and coaching sessions all over the world;
2. a. *Kiri Te Kanawa Foundation*, NZ: to help young, talented NZ classical singers (mentoring, financial support, career assistance);  
b. *Kiri Te Kanawa Foundation*, UK: to help talented young singers of all nationalities;
3. *Solti Te Kanawa Accademia di Bel Canto*: annual summer school for talented young classical singers in Tuscany;
4. Patron of the *Opera Factory*, NZ: for children 10+ and teens;
5. Sponsor of the *Opera School* within an ordinary school, NZ, through the Foundation;

6. a. Visiting Professor of Opera & Voice at the *Royal Academy of Music*, London;  
b. Visiting Professor of Vocal Studies and Opera at the *Royal College of Music*, London;  
c. Visiting Professor at the *Reykjavik Academy of Singing and Vocal Art*;
7. Honorary President of the *University of Wales Trinity Saint David International Academy of Voice*;
8. a. Head judge of *The BBC Radio 2 Kiri Prize*: for UK singers;  
b. Patron and member of jury of the *BBC Cardiff Singer of the World* competition: for all nationalities;
9. Private teacher of classical singers;
10. Guardian of classical singers in general.

Dame Kiri's sophisticated network could be *replicated* in local, regional and global business communities, universities and political organisations by *applying* it to the responsible leadership of talented young people, so that the ingenuity and mental resources of the future generation could be recruited to look after the sustainable wellbeing of humans and nature:

#### 1. *Responsible Leadership Master-Classes and Coaching Sessions All Over the World*

- When responsible political, business and academic leaders travel around the world, they could give hands-on responsible leadership master-classes to young, talented leaders in different countries to teach them techniques of responsible leadership: how to turn responsible values into responsible actions.
- They could also coach young, talented leaders worldwide how to execute responsible leadership in both everyday and threatening simulated real-life situations, e.g. in energy decision-making and in environmental emergencies.

#### 2. *Responsible Leadership Foundations*

Responsible political, business and academic leaders could set up foundations to

- mentor the most talented, totally dedicated, young responsible leaders;
- give them financial support for studies and global work experience in challenging circumstances;
- give them career assistance and advice;
- take them along to both everyday and threatening situations to practise their skills in different parts of the world.

#### 3. *Summer Academies of Responsible Leadership*

- Responsible political, business and academic leaders could set up summer academies for young, talented leaders dedicated to responsible leadership.
- The academies would be established in quiet places where the participants could concentrate fully on turning business, politics and science responsible.
- The academies would have the founders as regular teachers and annually changing visiting responsible leaders from all walks of life.

#### 4. *Patrons of Responsible Leadership Factories*

- Responsible political, business and academic leaders could help to establish and act as patrons of Responsible Leadership Factories in which children and teens could be trained during their free time to become responsible leaders.

#### 5. *Sponsors of Responsible Leadership Schools*

- Responsible political, business and academic leaders could help to establish and sponsor Responsible Leadership Schools set up at ordinary schools to enhance the responsible leadership skills of children and teens.

#### 6. *Visiting Responsible Leadership Professors at Universities*

- Responsible political, business and academic leaders could take visiting professorships at universities all over the world to advocate responsible leadership to young adults.
- They could give lectures, seminars, debates, simulations, master-classes and doctoral classes to encourage the young to become responsible leaders despite the challenges

the young will face in such roles in the still largely irresponsible political, business and academic worlds.

7a. *Responsible Universities*

7b. *Responsible Businesses*

7c. *Responsible Public Organizations*

- Responsible political, business and academic leaders could initiate and support the integration of responsible leadership into all activities of universities, businesses and public organizations from values, visions and strategies to decision-making and operations.
- Responsible political, business and academic leaders could initiate and support the development of pioneering universities, businesses and public organizations that choose responsible leadership as their mission.

8a. *The BBC Radio 1 Responsible Leadership Prize 2012*

8b. *The BBC Responsible Leader of the World Contest*

- Responsible political, business and academic leaders could establish and serve as judges in responsible leadership contests for young leaders both locally and globally.
- These contests could be broadcasted on the radio and on television.
- These contests would highlight the importance of responsible leadership among the general public, which would probably support it wholeheartedly

9. *Private Teachers of Young Leaders Aspiring to Become Responsible Leaders*

- Responsible leaders in business, politics and academia could give some of their free time to teach individually the most talented young leaders in their striving for becoming responsible leaders.
- They could also involve the young leaders in their own work, give them chances to try their skills and supervise them in real-life situations.
- In this way it would be possible to secure that the knowledge, expertise and experiences of the older generation of responsible leaders are passed on to the younger generation in every detail.

10. *Guardians of Responsible Leaders in General*

- Responsible leaders in business, politics and academia should protect and defend the responsible leadership students and young responsible leaders in the irresponsible world of business, politics and science.
- In this way they could help the young to succeed in establishing responsible leadership careers and in slowly but surely turning business, politics and academia responsible, thereby giving hope for a better future.

The suggested 10 different organizations for responsible leadership form a *network*, the *nodes* of which can be *integrated in many creative ways* like Dame Kiri is doing within her network of organizations. The different ways of integration build *individually tailored paths towards responsible leadership for the youngsters*. The network gives the framework in which to create the new world order of Genuinely Sustainable Development.

**Proceedings of the 18<sup>th</sup> Annual International Sustainable Development Research Conference, University of Hull, Hull, UK, 24 – 26 June 2012; Track 3d**

**EFFECTIVENESS OF INSTITUTIONAL INCLUSIVE POLICY MAKING: A CASE OF  
SUSTAINABLE ECONOMIC DEVELOPMENT IN INDIA**

**(Extended Abstract)**

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Track- 3d

Oral Presentation

## EFFECTIVENESS OF INSTITUTIONAL POLICY MAKING: A CASE OF SUSTAINABLE ECONOMIC DEVELOPMENT, INDIA

Indian economy has been growing with competitive growth rate in past few years. Last decade has been economically performing for India, which is backed up by the growth of Indian states. However, the social development has not been that shining indicator in the country. There are selected states of India, which could focus on the development agenda and formulate strategies, which helped them in improving their socio-economic indicators like Gujarat, Maharashtra, and Delhi etc. Economically, Gujarat has already achieved leadership in industries like chemicals, petrochemicals, drugs & pharmaceuticals, dairy, cement & ceramics, textiles, engineering, jewellery and automobile. Policy institutionalisation has played a visionary role in development of Gujarat, which has set the mandate of achieving the public interest objective. Access to economic infrastructure and social infrastructure by urban and rural population has been considered as a prerequisite for economic inclusion in many countries of world. As they evolved, some of government's policies interventions were aligned closely to the economic development of the underprivileged sections of the society.

The decade of year 2000 has indicated a strong economic growth of India, which was supported by some of the states of India. However, financial crisis in 2008 had an impact on Indian economy. Although Indian economy largely was saved by the raising savings and investment rates, large unfulfilled domestic demand, globally competitive firms, resilient banking system, policy of gradual liberalisation of capital account and governments quick response to the situation, it lost significant on socio-economic growth and GDP growth rate fell down to 5.8% in year 2008-09 as compared to previous year at 9%<sup>1</sup>. While in the reference of Gujarat, the economy grew at 11% during 2010-11<sup>2</sup>. As Indian designs its economic visions in 5 year planning; for the first three years of the Eleventh Plan (2007-12) Gujarat's gross state domestic product (GSDP) has grown at 10.07 %. Additionally, In the Tenth Plan the Indian economy grew at 7.8% against the target of 8.0%, whereas, Gujarat's economy achieved a growth rate of 11% as against target of 10.2% set by the Planning Commission<sup>3</sup>. In the planning commission national development council meeting (2010) state has indicated the strategy of Gujarat for the Eleventh Plan towards faster and more inclusive growth by development plans and integrating the policies and programmes in the following areas; Improvement of the Human Development Index (HDI), Investment in Human Capital, Skill Development and Employment, Empowerment through Education, Comprehensive strategy for better Health, Rural Infrastructure, Focus on the Unorganized sector, and Doubling real Income in less than 7 years.

As on 1 April 2008, Gujarat Chief Minister said his government would carry on the process of "Inclusive Growth" with special focus on marginal section of society and on 28 September 2009, he declares

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<sup>1</sup> Socio Economic Review of State of Gujarat, Department of Economics and Statistics, Government of Gujarat, 2009-10

<sup>2</sup> Gujarat has 11 percent GDP growth rate: Modi, "Way2Online", Jan 10th, 2011 (<http://www.indiazooms.com/?p=115248> extracted on 5/12/2011)

<sup>3</sup> Narendra Modi, presentation before National Development Council, Planning Commission, July 2010

Gujarat as a “No Village” state<sup>4</sup>. Gujarat is the second state at the position to declare no village state after Delhi in India. In 2011, Out of 28 states and 7 union territories, Gujarat stands first in health status, third place in literacy and first place in overall Human Development Index.

The transparency and inclusiveness in governance with tools like E-governance, E-procurement, E-city, E-gram, IT policy and the vibrancy in Judiciary has been one of the best in the country. While at one side country is lagging behind in achieving agricultural growth targets, Gujarat’s extraordinary performance has been applauded in many circles. The declaration of no-village status demands infrastructure at basic level for all stages including the basic requirements of industrial and commercial development, education reach to all, health services at every 5 km location and few other variables at minimum standards.

At a time when India is thinking and working on the Agenda of Inclusive Growth and national institutional mechanism is streamlining to make an effective system, state of Gujarat has silently worked on this being very much aware of the present jargons and achieved the basics of the inclusiveness in advance. The inclusiveness in the policy and the programmes at national level are offering an integrated approach which, however, not so effective in design and implementation due to lack of coordination in the institutional mechanism itself. The contradiction is so visible in Gujarat and it is to be studied indeed.

In the planning commission national development council meeting (2010) state has indicated the strategy of Gujarat for the Eleventh Plan towards faster and more inclusive growth by development plans and integrating the policies and programmes in the following areas; Improvement of the Human Development Index (HDI), Investment in Human Capital, Skill Development and Employment, Empowerment through Education, Comprehensive strategy for better Health, Rural Infrastructure, Focus on the Unorganized sector, and Doubling real Income in less than 7 years. The qualitative and quantitative assessments have been framed in the integrated scheme of development itself. Directorate of Evaluation which deals with ex post facto evaluation and recently, in 2007, Gujarat Social Infrastructure Development Board Society (GSIDBS) was established to undertake evaluation and impact assessment studies of ongoing schemes and programmes related to the social sectors.

The inclusive development and urbanization in Gujarat is intended to provide social infrastructure like school, community centre, post office etc. On human development indicators, Gujarat has changed significantly in last decade with 79.31% effective literacy rate (2011) as India has 74.04% overall literacy rate<sup>5</sup>, 24% birth rate and 7.4% death rate (2006)<sup>6</sup>. Education promotional schemes in the state for encouraging formal education among the youth with the special focus on the girl child amid the claim zero percent dropout rate being attended in several district of Gujarat. The change in state social

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<sup>4</sup> No villages in Gujarat, Delhi, declares CMs Narendra Modi and Sheila Dikshit, “The Economics Times”, Dhananjay Mahapatra, TNN Sep 28, 2009 ([http://articles.economicstimes.indiatimes.com/2009-09-28/news/28450063\\_1\\_gram-nyayalayas-village-courts-law-minister](http://articles.economicstimes.indiatimes.com/2009-09-28/news/28450063_1_gram-nyayalayas-village-courts-law-minister) extracted on 28/10/2011)

<sup>5</sup> Census report of India, 2011

<sup>6</sup> Third National Family Health Survey (NFHS-3) of India, 2005-06

indicator scenario has not happen overnight, since last decade the state machinery has worked tirelessly to put in place schemes and trust to cover all bases needed to bring in much needed behavioral change to alter the life cycle of poor and marginalized section of the state population. Under the effective governance leadership the state is able to achieve 2.09% dropout rate<sup>7</sup> from the class of 1<sup>st</sup> to 5<sup>th</sup> in overall state statistics.

Gujarat has approximately 6% of India's geographical area (19.6 million ha) and is home to around 60 million people (projected population based on Census 2011). The geographical distribution of population indicates about 57.42% of the population is classified as rural and 42.58% is urban as India has 31.16% of overall urban population. The state has around 5% of the total Indian population, contributes around 6.5% of all India GDP and 5.6% of all India GDPA. GSDPA constitutes around 16.8% of the GSDP (2006/07). Urbanized population growth rate around 19.7% over the past decade (as per the Census 2011), the reason behind this rapid urbanization growth rate is the rapid growth in industrial and service sector that Gujarat has witness over the last decade and currently stand at rank 1<sup>st</sup> in among the states of the country. This is meant to work as a regulatory framework rather than a project based approach to achieve the objective of inclusive growth.

Industrial products include cement and petrol, rather is has become the petrol capital of India. The year on year contribution in economy has been found as 39% of India's industrial output, 10% of its mineral production, 80% of salt production, 20% of India's exports, 25% of its textile production, 40% of India's pharmaceutical products and 67% of petrochemical production. Gujarat ranks first nationwide in gas-based thermal electricity generation with national market share of over 8% and second nationwide in nuclear electricity generation with national market share of over 1%. As per RBI report, in year 2006–07, 26% out of total bank finance in India was in Gujarat.

The leadership approach of the effective governance always presented a benchmark in the new area for the country by the same aroma of being a front benchmark for the nation Gujarat has installed the country biggest solar power plant on around 10,000 ha waste land in three different places (as state account for 14.4 million acre waste land) to ensure 3000 MW solar power project. State has 10.97% recorded annual agricultural growth rate since last decade. The ground behind this growth is not only the effective manure procurement and distribution policy and irrigation policy, it happens because of a systematic and structural approach since last decades. The state is able to include 13 lakh ha (waste land) of additional land under farming alongside establishing the state as number one on in systematic and scientific development of farm sector over the decade.

Gujarat bags Prime Minister's Civil Service Award 2011 for successful reduction in Sickle Cell Anemia on the civil service day 2011. The based behind this achievement of the states is a synergistic effect of other basic infrastructural approach for the socioeconomic development of the citizen of state like the 90% male and 76% female in the state has a mass media exposure (as 90% male and 74% female overall in India), 76% males and 48% females are belongs to the category of employed youth as compare to overall country only 64% male and 34% female youth are employed. To ensuring this growth in future

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<sup>7</sup> The Gujarat: An English Quarterly Magazine, Volume I, Issue III, July 20011



decade Gujarat government has launched e-broadcast project in 2011 by this project machinery has installed LED screens at the public place in the village and will give useful information to the public such as precautionary measure to be taken at the time of natural disaster, information of pro-people schemes, health services, up to date details of commodity rate and other vital information through this media.

Gujarat is moving far better on the road of providing basic health infrastructure to the citizen of state in comparison of the other states in the country as well as the country as a whole. For example state has 68% coverage of antenatal care among the youth as compare overall coverage in country is around 58%, in the term of institutional delivery state has 51% coverage as compare the country has only 41% coverage as a whole. State did much better to ensure the gender empowerment as in the term of sexual violence on the girl among the youth as violence is reduced up to 22% comparing the country has 34%. The basis behind the success is the lower alcohol consumption among the men as only 10% men are consuming the alcohol as country has more than 21% alcohol consumption among the men.

The success story of the state is motivation to study the policy framework and how has the policy integration designed and presented for implementation so reap maximum benefit for society by the same bureaucratic system of the country. This paper is an attempt to identify the critical policies, their functioning design, and the way these policies have been integrated to the best output. Paper also studies the state's approach towards inclusive agenda from socio-economic perspective and the policy links.

#### Reference:

1. Census report of India, 2011
2. Third National Family Health Survey (NFHS-3) of India, 2005-06
3. Socio Economic Review of State of Gujarat, Department of Economics and Statistics, Government of Gujarat, 2010-11
4. Socio Economic Review of State of Gujarat, Department of Economics and Statistics, Government of Gujarat, 2009-10
5. Narendra Modi, presentation before National Development Council, Planning Commission, July 2010
6. Rahul Singh, A Comprehensive Inclusive Development Policy for Sustained Living, International Conference on Public Policy, Jordon, 2009
7. The Gujarat: An English Quarterly Magazine, Volume I, Issue III, July 20011

#### Web links:

1. Gujarat seeks Rs 500 million to set up children's university "Theindian News" Tue April 10,2008 ([http://www.thaindian.com/newsportal/business/gujarat-seeks-rs500-million-to-set-up-childrens-university\\_10033379.html](http://www.thaindian.com/newsportal/business/gujarat-seeks-rs500-million-to-set-up-childrens-university_10033379.html) extracted on 28/10/2011)
2. No villages in Gujarat, Delhi, declares CMs Narendra Modi and Sheila Dikshit, "The Economics Times", Dhananjay Mahapatra, TNN Sep 28, 2009 ([http://articles.economictimes.indiatimes.com/2009-09-28/news/28450063\\_1\\_gram-nyayalayas-village-courts-law-minister](http://articles.economictimes.indiatimes.com/2009-09-28/news/28450063_1_gram-nyayalayas-village-courts-law-minister) extracted on 28/10/2011)

3. Gujarat has 11 percent GDP growth rate: Modi, "Way2Online", Jan 10<sup>th</sup>, 2011 (<http://www.indiazooms.com/?p=115248> extracted on 5/12/2011)
4. Gujarat records highest decadal agricultural growth rate of 10.97 percent, "The Economics Times", E T Bureau, Jul 16, 2011 ([http://articles.economictimes.indiatimes.com/2011-07-16/news/29781759\\_1\\_farm-sector-primary-sector-decadal](http://articles.economictimes.indiatimes.com/2011-07-16/news/29781759_1_farm-sector-primary-sector-decadal) extracted on 5/12/2011)

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## DRIVERS FROM THE MARKET - REACTION OF THE COMPANY

### Extended abstract

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### Abstract

Sustainable production and consumption is one of the key aims in the European Union's environmental policy. The European Commission recently presented a series of proposals on sustainable consumption and production that should contribute to improving the environmental performance of products and increase the demand for more sustainable goods and production technologies. The proposals also seek to encourage EU industry to take advantage of opportunities to innovate. Social, economic and ecological thinking can be an opportunity for all the actors in the production and consumption cycle where saving raw-materials, increasing energy efficiency, using by-products and reducing waste might be win-win situations for companies and their employees, shareholders, consumers, communities and the environment. Doing more with less, or, perhaps in many cases simply achieving the same with much less, is an example of 'living in the present' where attention to our economic growth approach, material and energy efficiencies and world without waste are a new focus for society. Legislation is one of the main drivers in improving material efficiency, but it may also become one of the main barriers. However, the most important barriers for environmental friendly innovations seem to be the investment costs and the high risk involved in committing capital to unproven technology. So-called market-based drivers, like corporate social responsibility, stakeholder pressure and also general public pressure, will also affect the investment decisions.

This paper assesses market-based drivers for effective industrial material use, the reactions of Finnish companies and the role of voluntary environmental management tools in influencing business strategy and decision-making. Our objective was to determine the market-based drivers that really assist in increasing the use of by-products and residues of the forest, chemical, and metallurgical industries in the present situation and in future. We also explore what kinds of instruments are guiding the industrial system in a more sustainable direction. Legal systems are effective in achieving their objectives once the most difficult step of determining the right objectives is achieved. On the other hand one must ask whether there is any other way to achieve the same objectives without legislation or of even defining the targets from a systemic point of view. In this respect it is often unclear, what the most optimum approach to control a system is and so other questions might be: can you control the system and can anyone be responsible for the whole system?

The research methods used were qualitative interviews, participatory workshops and literature research. The research material, especially the experiences in the metal sector, is based on semi-structured interviews of people and several participatory workshops held involving actors in the supply chain of the Finnish metals industry.

**Keywords:** Drivers, Decision making, Saving of the primary raw material, Material Efficiency, Sustainable production, Management, Business strategy, Incentive-based Economic Policy instruments

## **1 Introduction**

The economic is typically based on growth and technical superiority. The adoption of environmentally responsible business practices can open up an additional range of opportunities for companies with issues like sustainability in business providing new opportunities such as new methods of marketing, improving the efficiency of existing companies and reconfiguring existing business models and practices. Small and medium sized companies have a key role in this transition since in market-based economies entrepreneurs play a critical role in the adoption of green business practices by demonstrating the economic benefits, which come from being greener. However, green entrepreneurship is not only important because it provides new opportunities for forerunners, it also has the potential to be a major force in the overall transition to a more sustainable business. (Schaper (editor), 2005)

On 16 July 2008 the European Commission (EC) presented a series of proposals on sustainable consumption and production that will contribute to improving the environmental performance of products and increase the demand for more sustainable goods and production technologies. The first concrete steps of this new policy approach have been taken in the Communication on Integrated Product Policy (COM (2003) 302 final), in the Communication on the new Waste strategy (COM (2005) 666 final) and in the Sustainable Consumption and Production and Sustainable Industrial Policy (COM (2008) 397 final). These proposals also seek to encourage European Union (EU) industry to take advantage of opportunities to innovate. These proposals are an integral part of the EU's renewed Sustainable Development Strategy (EU SDS), which reinforces its long-standing commitment to meet the challenges of sustainable development and builds on initiatives and instruments at EU and international level such as the United Nations.

Within the supply chain there are many stakeholders, such as auditors, authorities, banks, competitors, insurance companies, the media, politicians and shareholders, who may have important roles and might influence the motives and opportunities to achieve environmental improvements. For a company to act, sufficient incentives are needed, often in the form of economic benefits. Also, large corporations might have major supply chain impacts on the business activities of their smaller suppliers. It is also important to note that different supply chain actors like raw materials manufacturers, the producer of the product, transport companies, and investors, may be subject to pressures from different drivers, although the goal and result might be the same.

Thus, the most important driving force for green initiatives seems to be financial. That costs are the most important single issue for business was highlighted by interviews regular reference to them when asked about drivers and barriers for more effective material use. Investments and price of the raw material are also important in the management decision-making. (Pajunen et al., 2011) Therefore, in this research we focus on economic drivers and business strategies of industrial companies. In particular we focus on market-based drivers for effective industrial material use, the reactions of the companies and the role of voluntary environmental management tools.

## **2 Economic and market-based drivers**

The most important driver for management is successful business and so the approach of using market-based instruments for environmental policy and natural resource management including environmentally related taxes, fees and charges, environmentally-motivated subsidies, tradable permits systems and deposit-refund systems etc. effectively couples with this prime driver. Whereas legislative approaches mainly consist of enforcements and restrictions, economic instruments are designed to provide more positive financial incentives to promote more favourable forms of production and consumption. (Tab. 1) Economic instruments include selective taxes and fees, as well as various kinds of subsidies, grants and tax exemptions, for both companies and individual citizens. The key feature of all these measures is that authorities are involved at one end of the financial transaction.

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Table 1. Obligatory, financial and competition-based drivers

Obligatory drivers	Financial drivers	Competition-based drivers
Waste Directive	Price	Competitor's environmental choices
Finnish Waste Act	Costs	Demand on the subcontractors
Finnish Environmental protection Act	Supply and demand	Decisions of the competitors
Finnish Tax Act	Demand from the market	Image
Producer's responsibility	Green purchases	Expectations of the customers
Polluter pays -principle	Taxes	Pressure from the market
	Saving the energy	Competitiveness in local and global market
	Material efficiency	
	Profitable business	
	Supply chain	
	Interest group	

Obligatory drivers, such as laws and directives, are well known in the surveyed companies and in most case they have usually been involved in consultations on new law concerning their industrial field and have already commented on it at the drafting phase. Environmental Impact Assessment (EIA) and Environmental permit procedures include most of the legal obligations. Financially based drivers are important from a business point of view and these kinds of issues are obvious inclusions to make in the strategy and business plans of companies. Competition, the expectations of customers, image and demands of subcontractors are more or less important to know but reaction time is variable. However, grouping the drivers from the market is more or less only a frame. The most important driver for a company is to have a profitable business that is valuable to its shareholders.

Economic instruments are quite clearly effective in creating business reactions on financial grounds however it is a question of whether the reaction is in line with the intended outcome that is of issue. In order to ensure that such instruments remain appropriate for their intended purpose it is important that they are properly monitored and revised sufficiently often to take into account factors such as advances in technology or perverse side effects (unintended outcomes). The term "market-based instruments" is used here as a general term to refer largely to the different calls for environmental protection transmitted through the markets. Some examples of market-based drivers in our research case are: legislation introduced on export markets, e.g., demands for the use of recycled fibres; environmental labels and environmental demands from end-users.

### 3 Strategic decisions for green supply chain management

In this chapter we focus on business strategy, environmental management and decision-making process. The decision-making process can be summarised in a few steps: definition of possible alternatives; evaluation of alternatives and making a decision. The definition on the alternatives includes a wide range of options as alternatives cannot be excluded until after evaluation. (The Role of LCA in Decision making in the context of Sustainable Development, 2007) When concerning environmental aspects, evaluation is based on criteria such as material and energy efficiency, environmental impacts of production and use phases and life cycle thinking.

The concern about the environmental impacts of business has affected companies in many ways. The demand of sustainability in industrial processes will require changes to the management and operations of the companies. Companies have to react to new regulations, which reflect increasing concerns about the socio-environmental impacts of business. As Peattie and Charter (1997) have argued, green driving forces are having effects in both visible and invisible ways. Also drivers, such as green image values, the possibility to develop the process and increasing market share, are more or less related to business. (Pajunen, 2011; Pajunen et al., 2012)

It will be crucial for success of the industrial company to internalize the value of environmental thinking and the life cycle approach. Products and product development has to take place through the entire supply chain, not only in one individual company. One approach for this is an inter-organisational environmental management system. (Sinding, 2009) In addition communication with stakeholders and customers emphasizes proactive environmental strategy and should be a two-way process in order to keep ahead of legislation and customer demands for improvement, and allow participation in discussion regarding environmental issues. It is also obvious that poor environmental strategy and performance can put a company at a massive competitive disadvantage. (Peattie and Charter, 1997)

Companies are always surrounded by other actors, such as law makers, shareholders, banks, insurance companies, the media, politicians and auditors, competitors and authorities. Also within the supply chain there are many stakeholders, such as contractors, supply and service providers and customers. (Fig. 1) They all may have an important role and might influence the motives and opportunities to achieve environmental improvements. Greening is forcing companies to also reconsider supplier relationships, because their total environmental impact is strongly influenced by the supply chain.

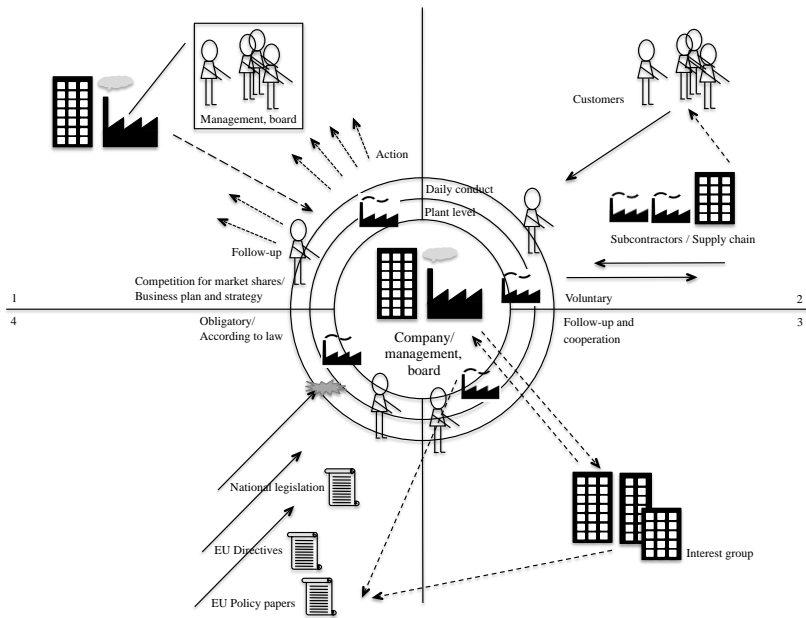


Figure 1. Drivers and a reaction of the company

Decisions of a corporate strategies, business plans and operational decisions are much more complex and interconnected than those of the past because of social, environmental, and economic concerns. (Courtney, 2001) There may be considerable differences in detail in the way environmental decisions are made as a result of legal, political, economic and other social factors (Harding, 2002). In our research the main evaluation criteria for environmentally friendly decisions was material efficiency; recycling rate and the prevention of waste. Environmental strategy has to go hand in hand with business strategy since environmentally strategic decisions and processes are expressing adaptation to opportunities, threats, constraints and other characteristics of the environment. (Papadakis et al., 1998)

Environmental decisions involve many different stakeholders with different priorities or objectives. Most people, when confronted by complex and multifaceted decision problems, will attempt to use intuitive approaches to simplify the complexity until the problem seems more manageable. (Kiker et al., 2005) When the company has chosen an environmentally friendly way to act, they also have to have indicators to evaluate the decision both from business point of view and environmental point of view. (Fig. 2)

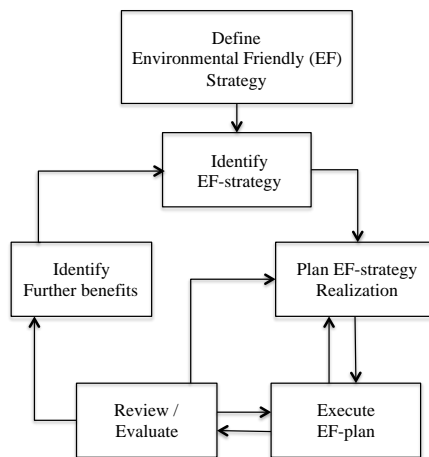


Figure 2. Environmental friendly (EF) management.

Effective environmental decision-making requires a clear structure for coordinating joint consideration of the relevant factors, such as environmental, technological, economic and social, to evaluating and selecting management alternatives. Each of these factors includes multiple subcriteria. To integrate this information with respect to human aspirations and technical applications demands a systematic framework to organize the processes and tools for making a defensible decision. (Kiker et al., 2005) It is also important to understand the complexity between environmental and economic aspects. Economic outcomes may be influenced by a variety of factors. (Goll and Rasheed, 1997) So, environmental investments must be seen also as a possibility.

When organizations incorporate environmental issues into strategy, business plans and operational decisions the influences of the decisions will not only effect the organization that makes the decision, but also its customers, suppliers and the whole supply chain. A number of business and environmental factors therefore need to be integrated into the decisions. (Sarkis, 2003)

At present almost all heavy industrial companies are present on international stock exchanges. Quarterly reporting periods and this institutionalised quarterly reporting thinking in the financial sector does not go hand in hand with life cycle thinking and sustainability. In research and development (R&D) work the time frame is often counted in multiple years not in days. That R&D plays a crucial role in successful implementations of new ideas and technologies is not in doubt, with companies with high R&D intensity tending to generate more positive reaction among investors in implementing green supply chain projects. (Bose and Pal, 2012)

Confidential co-operation between companies in the supply chain needs time and patience to await results. Products and product development has to take place through the entire supply chain, not only in one individual company. In addition communication with stakeholders and customers emphasizes proactive environmental strategy and also other way round. Green supply chain management might also bring value to organizations. Sustainability issues are taken up by many organizations worldwide for creating value to the shareholders. (Bose and Pal, 2012) Since 1999, the Dow Jones Sustainability Index has been tracking the financial performance of the leading sustainability-driven companies across the world (Knopf, 2001) and includes the top 10% of the biggest companies based on a long-term economic, environmental and social criterion. (Bose and Pal, 2012)

In the final analysis reactions and decision-making is always also a question of the moral, ethical and values. Every individual has the opportunity to choose and make decisions in a moral and ethical way: to choose the most equitable and valuable procedure, behaviour and method. The moral and ethical approach strives to rank the alternatives by assessing superiority between them. An individualistic approach is: "what is right for me is also right for others". A multidisciplinary ethic can be analysed by development and scale of region; the planet, continent, European Union, nation and regionally. Different areas are creating different ethical and moral views and needs. Also social and cultural development and the background of the nation raises ethical questions like economy, technology, politics, science and environment. The target is to achieve the balance between every part of the wholeness. (Heikkonen, 1995)

#### **4 Conclusions and discussion**

Environmental targets are important and actually obligatory for industrial companies already and will be more so in the future. Environmental policy, such as IPP and other EC papers at EU level and global level developments are proceeding in any case towards assisting in the process of moving towards less unsustainable operations. Steps towards a more environmentally friendly society such as taxes, environmental permits and EIA procedures are combining with increasing material and energy efficiencies in improving sustainability in supply chains driven by financial gains for companies.

The most important driver for a company is however to have a profitable and sustainable business that increases its value to shareholders. The profitable business can use efficient instruments like environmental management systems (i.e. ISO 14001) to drive forward initiatives, monitor, review and steer operations and to provide information that meets its stakeholders needs.

Environmental decisions are made as a result of the interplay of complex legal, political, economic and other social factors notwithstanding general moral and ethical considerations that strive to rank alternatives by assessing superiority. The social and cultural development and background of a particular nation also raises ethical questions that influence its approach to questions of economy, technology, politics, science and the environment.

Business is of course a key target of most environmental policies, however, since IPP takes a product's life cycle as its starting point, the number of actors targeted increases considerably to include not just large industrial units, but also the whole product chain from raw material extraction via manufacturers, retailers and consumers to waste managers, who can all be made directly or indirectly responsible for environmental protection.

The short term thinking encouraged by financial reporting and the time horizons over which financial returns are generally expected and or are acceptable to businesses and investors does not go easily hand in hand with life cycle thinking and sustainability. In research and development work the time frame is often one of years and not months. It needs time and patience to wait results. This goes for greening business benefits as well as progress towards sustainability.

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## REFERENCES

### **Literature:**

Ammenberg, J. and Sundin, E.: Products in environmental management systems: drivers, barriers and experiences, *Journal of Cleaner Production*, on May 2003.

Bose, I., Pal, R.: Do green supply chain management initiatives impact stock prices of firms. *Decision Support Systems* 52 (2012), 624-634.

Brady, J. (edit.): Environmental management in organizations. The iema Handbook. 2005.

Coen, D. and Grant, W.: Managing business and Government Relations. In Coen, D. and Grant, W. (eds.), *Business and Government: Methods and Practise*. Opladen and Farmington Hills: Barbara Budrich Publishers, 13-31. 2006.

Cornwall, A.; Jewkes, R.: What is participatory research? *Social Science & Medicine* 41.12: 1667–1676, 1995.

Courtney, J., F.: Decision making and knowledge management in inquiring organizations: toward a new decision-making paradigm for DSS. *Decision Support Systems* 31 (2001) 17-38.

Denzin, N., K. and Lincoln, Y., S. (editors): *The sage handbook of qualitative research*, third edition, 2005.

Goll, I., Rasheed, A., M., A.: Rational decision-making and firm performance: The moderating role of environment. *Strategic Management Journal*. Vol. 18:7, 583-591 (1997).

Heikkonen, J., 1995: Moraali ja etiikka käytännössä. (in Finnish).

Kiker, G., A., Bridges, T., S., Varghese, A., Seager, T., P., Linkov, I.: Application of Multicriteria Decision Analysis in Environment Decision Making. *Integrated Environmental Assessment and Management*. Volume 1, Number 2, 95-108.

Pajunen, N.: By-products of the heavy industry - drivers, barriers and the business opportunities, the Licentiate Thesis, 2011, (in Finnish).

Pajunen, N., Watkins, G., Wierink, M., Heiskanen, K.: Drivers and barriers for effective industrial material use. *Minerals Engineering*, Volume 29, March 2012, pages 39-46.

Papadakis, V., M., Lioukas, S., Chambers, D.: Strategic Decision-Making Process: The role of Management and Context. *Strategic management Journal*. Vol. 19, No 2 (1998), 115-147.

Peattie, K., Charter, M.: Chapter 28 Green Marketing in the *The Marketing Book* (fifth edition) edited by M. J. Baker, 1997.

Radaelli, C. M.: Whither better regulation for the Lisbon agenda? *Journal of European Public Policy* 14(2): 190-207. 2007.

Salmi, O., Hukkinen J., Heino J., Pajunen, M., Wierink, M.: Governing the interplay between industrial symbiosis and environmental regulation: the case of the Gulf of Bothnia heavy industries in Finland and Sweden. *Journal of Industrial Ecology*, Volume 16, Number 1. 2011.

Sarkis, J.: Supply chain management and environmentally conscious design and manufacturing. *International Journal of Environmentally Conscious Design and Manufacturing*. 1995: 4 (2), 43-52.

Sarkis, J.: A strategic decision framework for green supply chain management. *Journal of Cleaner Production* 11 (2003), 397-409.

Sinding, K.: Environmental management beyond the boundaries of the firm: definitions and constraints. *Bus Strategy Environ*, 2009; 9: 79-91.

Schaper, M. (editor), 2005: Making Ecopreneurs: Developing Sustainable Entrepreneurship.

The Role of LCA in Decision Making in the Context of Sustainable Development. A report prepared for Beacon Pathway Limited. 2007.

### **EU Legislation and Policy papers:**

DIRECTIVE 2008/98/EC on waste

EC (2003a), 'EC Communication IP/03/858, Integrated Product Policy; Commission outlines its strategy to stimulate greener products, European Commission, Brussels, 2003.  
<http://europa.eu/rapid/pressReleasesAction.do?reference=IP/03/858&format=HTML&aged=0&language=EN&guiLanguage=en>, (accessed 9.5.2012)

EC (2003b), 'COM/2003/0302 final, Communication from the Commission to the Council and the European Parliament - Integrated Product Policy - Building on Environmental Life-Cycle Thinking, Brussels, 2003. <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:52003DC0302:EN:HTML> (accessed 9.5.2012)

EC (2005a), 'COM/2005/0666 final, Taking sustainable use of resources forward - A Thematic Strategy on the prevention and recycling of waste', Communication from the Commission to the Council, the European Parliament, the European Economic and Social Committee and The Committee of the Regions SEC(2005) 1681, 1682, Brussels, 2005.

EC (2005b). Communication from the Commission to the Council, the European Parliament, the European Economic and Social Committee and the Committee of the Regions. Thematic Strategy on the sustainable use of natural resources. COM(2005) 670 Final, Brussels, 21.12.2005. <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2005:0670:FIN:EN:PDF> (accessed 9.5.2012)

EC (2006a), Review of the EU Sustainable Development Strategy – Renewed Strategy 10917/06. Council of the European Union, Brussels, 2006. [http://ec.europa.eu/sustainable/docs/renewed\\_eu\\_sds\\_en.pdf](http://ec.europa.eu/sustainable/docs/renewed_eu_sds_en.pdf), (accessed 9.5.2012).

EC (2006b), 'EC Communication COM(2006) 689 final, A strategic review of better regulation in the European Union', European Commission, Brussels, 2006.

EC (2008b), 'Directive 2008/1/EC concerning integrated pollution prevention and control (Codified version)', Official Journal of the European Union, Brussels, 2008.

EC (2008c), 'COM(2008) 397 final, Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions on the Sustainable Consumption and Production and Sustainable Industrial Policy Action Plan, SEC(2008) 2110, 2011, Brussels, 2008. <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:52008DC0397:EN:NOT>, (accessed 9.5.2012).

EC (2009a), Directive 2009/125/EC of the European Parliament and of the Council of 21 October 2009 establishing a framework for the setting of ecodesign requirements for energy-related products. <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:32009R0641:EN:NOT>, (accessed 9.5.2012).

EC (2009b). Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions - Mainstreaming sustainable development into EU policies : 2009 Review of the European Union Strategy for Sustainable Development, COM/2009/0400 final. <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:52009DC0400:EN:NOT>(accessed 9.5.2012)

EC (2010a), 'European Commission - Guidelines on Waste Prevention Programmes 2010', European Commission, Brussels, 2010. [http://ec.europa.eu/environment/waste/prevention/pdf/Waste%20Prevention\\_Handbook.pdf](http://ec.europa.eu/environment/waste/prevention/pdf/Waste%20Prevention_Handbook.pdf), (accessed 10.01.2011)

EC (2011a). Industrial policy. Industrial competitiveness. Europe 2020 flagship: An Industrial Policy for the Globalisation Era. [http://ec.europa.eu/enterprise/policies/industrial-competitiveness/industrial-policy/index\\_en.htm](http://ec.europa.eu/enterprise/policies/industrial-competitiveness/industrial-policy/index_en.htm), (accessed 9.5.2012)

EC (2011c). Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. A resource-efficient Europe – Flagship initiative under the Europe 2020 Strategy. Commission, Brussels, 26.1.2011, COM(2011) 21. [http://ec.europa.eu/resource-efficient-europe/pdf/resource\\_efficient\\_europe\\_en.pdf](http://ec.europa.eu/resource-efficient-europe/pdf/resource_efficient_europe_en.pdf), (accessed 9.5.2012)

EC (2011d). Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. Tackling the Challenges in Commodity markets and on Raw Materials. European Commission, Brussels 2.2.2011, COM(2011) 25 final. [http://ec.europa.eu/enterprise/policies/raw-materials/files/docs/communication\\_en.pdf](http://ec.europa.eu/enterprise/policies/raw-materials/files/docs/communication_en.pdf)

European Sustainable Consumption and Production Policies [http://ec.europa.eu/environment/eussd/escp\\_en.htm](http://ec.europa.eu/environment/eussd/escp_en.htm)

**Environmental Management Accounting for Sustainable  
Development and the Eyes of Chinese Wisdom – Yi Jing**

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**Abstract**

Environmental management accounting (EMA) has been used in Western countries for many years. Many successful cases in improving resource use efficiency and helping to implement more sustainable industrial practices have been reported. However, EMA application in Asia, especially in China is still limited. Some researchers suggest that cultural difference can be an adaption barrier. This research paper attempts to integrate the ancient Chinese wisdom –Yi Jing with the technology from the West – EMA, making it more suitable in the Chinese environment.

**Introduction**

Littleton described accounting as ‘relative and progressive’ (Littleton, 1933). He emphasized that ‘.....older methods become less effective under altered conditions; earlier ideas become irrelevant in the face of new problems. Thus surrounding conditions generate fresh ideas and stimulate the ingenious to devise new methods. And as such ideas and methods prove successful they in turn begin to modify the surrounding conditions.’ More than 7,000 years ago, Assyrians in Mesopotamia prepared accounting records to record growth of crops and herds (Friedlob G. and Franklin J. Plewa Jr., 1996). New accounting practices like double entries, accounting information systems were developed and improved over the years as business advanced. Nowadays, accounting is the ‘language of businesses. Firms make use of management accounting to formulate strategic business decisions and to report and monitor their routine operations. Also, firms use financial accounting to report firms’ performances to people outside the organization like the investors, the governments and regulators.

The ecosystem provides many things to people for free: air, water, natural resources, etc. In the capitalist environment, the ultimate function of a firm is to maximize the shareholders' wealth. As economic activity grows, people take too much from the ecosystem. We have observed extinction of many plants and animals, pollution causes serious illness and even death. In 1987, the World Commission on Environment and Development of the United Nations defined sustainable development as:

*'Development that meets the needs of the present without compromising the ability of future generations to meet their own needs.'* (WCED, 1987)

Sustainable development is not a fashion but a necessity. As Littleton suggested, accounting interacts with the surroundings. Sustainable development cannot be achieved without new accounting practices. Environmental management accounting (EMA) is developed to help firms to identify and to reduce environment costs and ultimately, it support sustainable development. Many firms in West (for example, Sainsbury) have practiced EMA and result in environmental cost reduction. However, in the East, especially China, the adaption of EMA is slow. Cultural difference may be a cause for slow EMA adaption in China.

This paper is divided into three main parts. Firstly, we introduce the relationship of Yi Jing and China. Secondly, we will briefly introduce what is environmental management accounting (EMA). Finally, we propose how Yi Jing can be integrated with EMA with the aim to motivate Chinese managers to adapt EMA.

### **A brief introduction of Yi Jing**

Chinese culture is one of the more complicated cultures in the world, largely due to its history and the intertwining of many schools of thought over it (Chen and Lee 2008). Yi Jing (Book of Change) is said to be the source of ancient Chinese wisdom. Yi Jing appeared in China more than 3000 years ago. It was said that the legendary saga Fuxishi, King Wen of Zhou Dynasty and his son, King Wu were the main contributors (Mun, 2006). Since the Han Dynasty (206 B.C. to A.D. 219), Yi Jing was considered to be the book of wisdom and philosophy. In ancient China, Yi Jing had been applied in different fields. For example, it was the foundation of Confucianism, Laozi, Daoism. It had extensive application in science including mathematics, astronomy, and architecture. In daily life, Yi Jing was used for fortune telling, Chinese herbal doctors and even kung fu masters.

The fundamental of Yi Jing is Tai-ji, Yin-yang and the Five- elements (metal, wood,

water, fire and earth). In this paper, we focus our discussion on Tai-ji and Yin-yang.

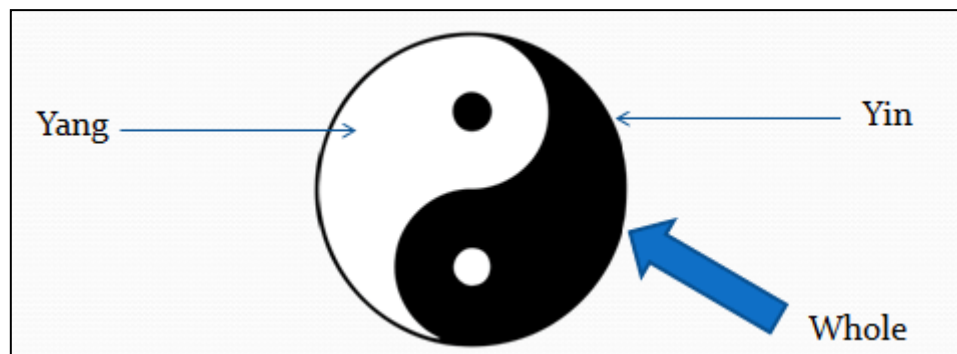


Figure 1 Tai-ji

The principle of Yi Jīng was Tai-ji (Figure 1) of which the ancient Chinese believed it was the origin of the universal evolution. Yin and Yang were the two forces that formed the Tai-ji. Chinese thought that Yin represented darkness or female while Yang represented light or male. When Yin and Yang were separated, their relationships were in opposite (dark and light, female and male) but when Yin and Yang were united, they became the whole or strength.

Tai-ji is a closed system. Tai-ji produced two ‘forces’ (Yin and Yang). The two forces generated four ‘states’: old Yang, young Yin, young Yang and old Yin (Figure 2). The four ‘states’ produced eight trigrams which represented observations of the nature: heaven, lake, fire, thunder, wind, water, mountain and earth. Each of the natural observation represented a particular characteristic (Table 1).

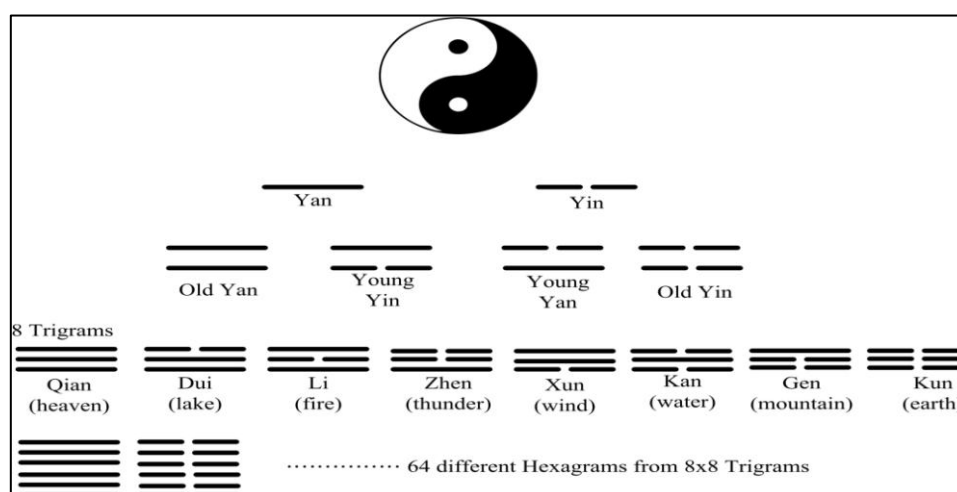


Figure 2 Closed system of Yi Jīng









Trigram	Characteristics
 Heaven	active, energetic
 Lake	joy, delighted
 Fire	bright, understanding
 Thunder	powerful, moving
 Wind	gentle, penetrating
 Water	dangerous, difficult
 Mountain	stable, still
 Earth	passive, soft

Table 1 Characteristics of trigrams

When two trigrams joined together, it became a hexagram. In Yi Jīng, there were 64 hexagrams. In every hexagram, there was a hexagram statement (Xici) which represented the macro situation for determining the favorable or unfavorable condition. Each Yin or Yang line in the hexagram also had a statement that described the micro situation within the macro situation.

The Tai-ji symbol represented its most important concept: harmony. Under the concept of Tai-ji, harmony was not static. All development was a continuous and cyclical movement from two extremes: imbalance to balance (harmony). The complementary relationship in Figure 1 demonstrates the well balance between Yin and Yang. Also, in the system of Tai-ji, time and space changed simultaneously.

## Western and Chinese Views of Sustainable Development

Relationship between man and the nature is very different between traditional Western thinking and traditional Chinese thinking. Traditionally, Western people emphasis individualism and men conquer the nature. However, Chinese philosophers prefer

immanence and unity.

The idea of sustainable development in the western world started in last century. When considering the three major aspects of sustainable development (economic, social and environmental developments), western people consider sustainability is the intersection between them (Figure 4) (Elkington, 1998)

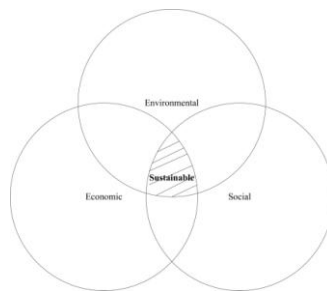


Figure 4 Sustainable development: Western view

However, the concept of sustainable development was well developed in ancient China. During the Spring and Autumn and Warring States Period (around 700 B.C. to 246 B.C.), there were already restrictions that prohibited excessive foresting and prohibited hunting of pregnant animals to preserve spices. Also, the ancient Chinese acknowledged that humans were just a small part of, and closely linked to the world. The idea of 'Tian Ren He Yi' (human and the heaven are united) were share among most of the ancient Chinese philosophers (e.g. Laozi, Zhuangzi, etc). Traditionally, Chinese people prefer long lasting people relationships and firms make profits from harmony with the environment and people in the society. Graphically, the relationship of the harmonious development elements using traditional Chinese will is shown in Figure 5.

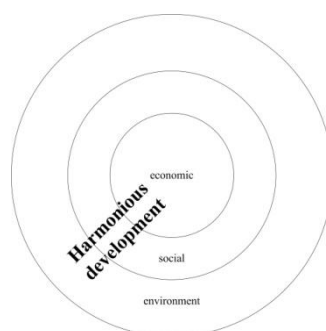


Figure 5 Harmonious development: traditional Chinese view

In the past decade, science and technology advancement in the West makes Chinese think that Chinese traditions are outdated or antiquated. However, after the financial



crisis, doing business in a ‘Chinese way’ becomes popular when China becomes a strong force in supporting global recovery. Moreover, traditional Western classical theories are challenged (Zoellick, 2010). The world now requires multi-polar knowledge.

## Analyzing China’s Sustainability Problem using Yi Jīng

Our planet is facing sustainability problem and China is also one of the victims. This paper uses hexagrams from Yi Jīng to analyze the current situation in China.

### *Economic Development*



Sheng

China is having rapid economic development in the past thirty years. Data from World Bank showed that the average GDP of China from 1980 to 2010 was 10% per year. Hexagram ‘Sheng’ can best describe this situation. ‘Sheng’ is a combination of ‘earth’ trigram on top and ‘wood’ trigram at the bottom which means trees are growing on earth when they mature. It emphasis on soft progress and aggressive progress is harmful. The strong economic growth has caused serious environmental problem in China.

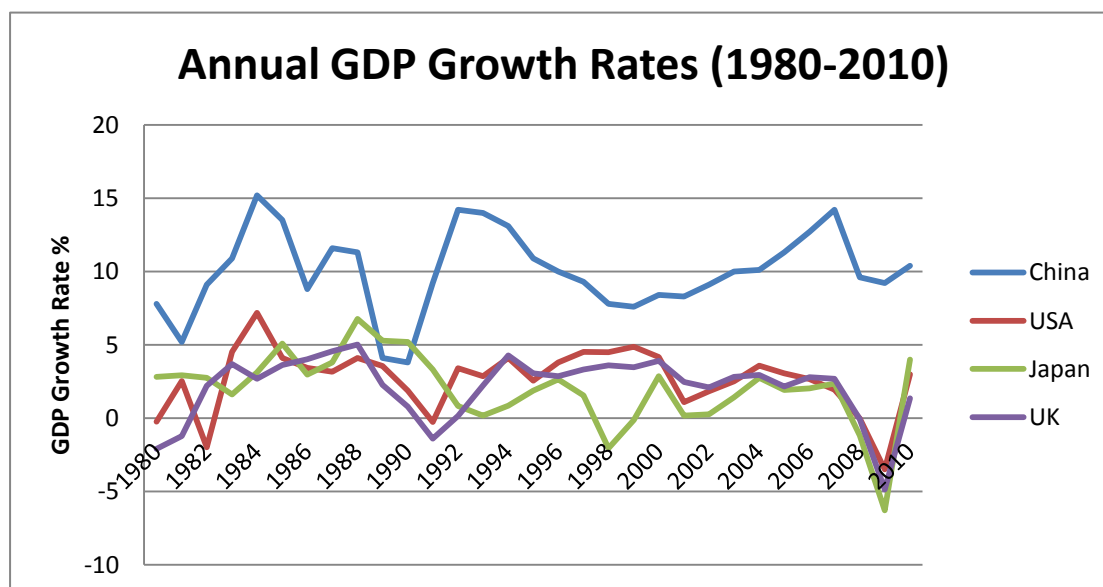


Figure 6 GDP of China and USA (1980-2010)  
(Source: World Bank)

## Environmental Issues



Kun

China is suffering from serious environmental issues. Respiratory and heart diseases related to air pollution are the leading cause of death in China. In addition, about 40% of the water in China's river systems has a quality index of 3 or worse, which is unfit for human consumption (WWF, 2012). WWF estimated that by 2025 China will be the world's leading producer of greenhouse gases. This alarming situation is best represented by the 'Kun' hexagram. The upper trigram of 'Kun' is 'lake' and the lower trigram is 'water' which means water is leaking from the lake and the lake is drying up. The meaning of 'Kun' is exhaustion and in dangerous condition.

## Government Actions



Ge

The upper trigram of Ge is 'lake' and the lower trigram is 'fire' which means there is conflict between lake and fire and this leads to reform. It means that people has recognized the problem and the prospects for reforms are bright and regrets will disappear. In March 2011, China's National People's Congress approved its 12<sup>th</sup> Five-year plan from 2011 to 2015 (National People's Congress of People's Republic of China 2011). This plan emphasized 'high quality growth, harmonious development'. The Chinese government establishes hard targets on nitrogen oxide and ammonia nitrogen reduction of 10%. The plan also wants to cut energy consumption per unit of GDP by 16%. These hard targets create challenges for the manufacturing industries in China.

## Brief Introduction on Environmental Management Accounting

Researchers observed that conventional accounting systems ineffective to support sustainable development where environmental costs were assigned to overheads rather than to trace them to product and processes (Jasch, 2003, IFAC 2005, UNDSO, 2005, Gale, 2006). Gale suggested that polluting companies paid three times for non-product output (wastes and emissions). First, the company pays the cost of purchasing raw materials where a proportion of which ended up as wastes and emissions. Second, the company paid for the operational use of raw materials through labor and infrastructure investment costs, a proportion of which also ended up as wastes and emissions. Traditional accounting had limited ability to identify and trace such costs.

There is no single definition and scope of environmental management accounting (EMA). Birkin (1996) identified the goal of EMA was to optimize the efficiency of companies' resource conversion processes. EMA was concerned with the provision and interpretation of relevant information which assisted management in planning, controlling, decision-making and appraising performance. Burritt et al. (2002) integrate the notions of monetary information and physical information to refine the concepts of EMA. Monetary information concerns "environmentally related impacts on the economic situation of companies", while the physical information concerns "company related impacts on environmental systems". The positioned EMA according to two predefined dimensions: "users of the information" and "nature of the information"

Jasch (2003) suggested that EMA was a fusion between management accounting, financial accounting and environmental management system. IFAC (2005) defined EMA as *"the identification, collection, analysis and use of two types of information for internal decision making:*

- physical information on the use, flows and destinies of energy, water and materials (including wastes) and*
- monetary information on environment-related costs, earnings and savings."*

The United Nations Division of Sustainable Development (2005) offered a broader definition of EMA where EMA represented a combined approach which provided the transition of data from financial accounting and cost accounting to increase material efficiency, reduce environmental impact and risk and reduce costs of environmental protection.

### **EMA's Benefits to Chinese Firms**

From a survey on Australian firms, it was found that EMA use had a positive association with process innovation (Ferreira and Moulang, 2010). By improving the inefficient processes, firms could achieve higher efficiency or higher quality from its improved processes and would ultimately improve its market and economic performance (Bansal and Roth, 2000). In order to achieve the targets of the 12<sup>th</sup> Five-year plan, firms need to improve their manufacturing processes for meeting the pollution reduction targets. EMA is a valuable tool at firm level to address the national targets.

## **Oriental EMA**

In financial accounting, the adaption of the International Financial Reporting Standards (IFRS) has caused harmonization of financial reporting in China with the rest of the world. However, management accounting is still 'internal' to the firms, national culture plays its role in influencing the management accounting system used by firms. Hofstede considered culture was *'the collective programming of the mind that distinguishes the members of one group or category of people from another.'* (Hofstede 2001)

Culture related factors, which encompass traditional management norms and practices affect adoption of management accounting practices (Liu and Zhang, 1996; Hoon-Halbauer, 1999; MacArthur, 2006; Chanegrih, 2008). In analyzing American and German management accounting systems using Hofstede's national cultural model, MacArthur concluded that the successfulness of the implementation of a foreign management accounting practice largely depend on the national culture of the firm that implement the new practice. Chinese were high uncertainty avoidance with high power distance and low individualism. (Hofstede, 2001; Chow, Chau and Gray, 1995). Zhuo (2007) suggested that management accounting from the West challenged the traditional Chinese norms and this caused management accounting practices unpopular in Chinese firms.

EMA is an improved form of management accounting that can help managers to discover hidden costs (Jasch, 2003). Local governments and provincial officials in China are required to take very serious responsibility for their environmental performance and to support the harmonious development. They need practical programmes for directing business initiatives to improve environmental performance. Although business sectors have taken initiatives in response to improve energy efficiency, they still need better and more systematic managerial tools in supporting harmonious development. The 'Oriental EMA' integrates the concepts from Yi Jīng into EMA can be a valuable tool to the Chinese officials and Chinese managers.

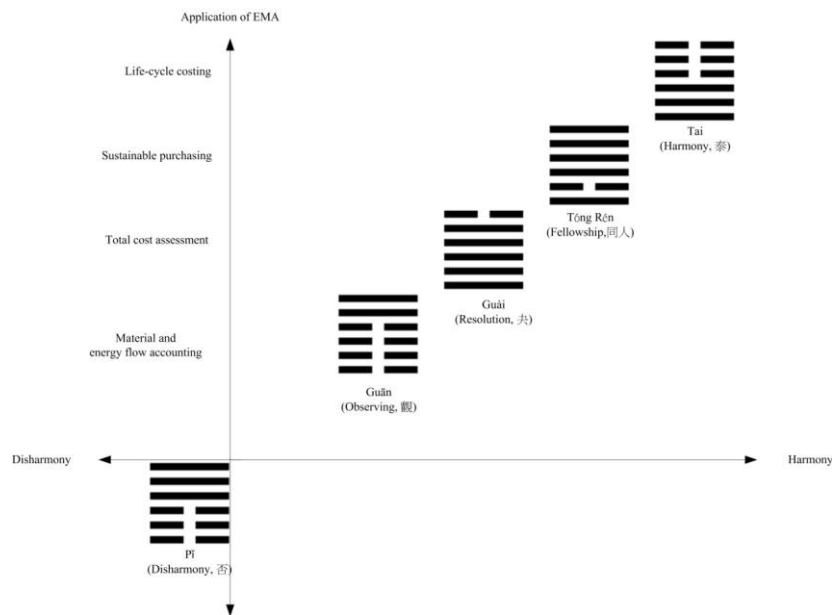


Figure 8 Oriental EMA Model

In Oriental EMA model, firms support sustainable development progress from one extreme (disharmony) to another extreme (harmony). Below is the discussion of each stage and the suitable EMA tool for that stage.

#### *Stage Pǐ (Disharmony, 否)*



In this hexagram, ‘heaven’ is on top and ‘earth’ is below. Although heaven and earth are in proper position, there is no interaction between them. Selfish firms focus only on growth and profitability. Firm may do things which are harmful to the social welfare (e.g. fail to provide proper working conditions) or to the environment (discharge pollutants to the environment) in order to meet the profitability targets. Obviously, when a firm is in Pǐ stage, the firm does not adapt any EMA practices.

#### *Stage Guān (Observing, 觀)*



This hexagram looks like an observing tower. The upper trigram is ‘wind’ and the lower trigram is ‘earth’. When companies are in this stage, they review their external and internal situations for taking timely and suitable adaptations for supporting sustainable development.

Material and energy flow cost accounting (MFCA) can be applied to identify

inefficiencies in terms of environmental and economic costs at product, functional and corporate levels. MFCA is an equation based on “*what comes in must go out - or be stored*” (United Nations Division for Sustainable Development 2005). All items (materials, water and energy inputs) are measured in physical units in terms of mass (kg, t), liters or energy (MJ, kWh). The material inputs are then matched with the amounts produced, sold and any waste and emissions and the differences represent the areas for improvement.

#### *Stage Guài (Resolution, 夬)*



In this hexagram, ‘lake’ trigram is above ‘heaven’ trigram. This hexagram represents when lake is in the sky, the thunderstorm is coming. This means that after assessing the inefficiencies, firms have to find suitable solutions to address the inefficiencies and there will be breakthroughs.

Firms will change the production process, use new materials or to invest in new machines. Traditional assessment tools like net present values (NPV), internal rate of returns (IRR) do not support sustainable development since they fail to consider environmental and social costs. Traditional capital budgeting methods compare different capital investment alternatives using only labor and equipment costs

Total Cost Assessment (TCA) is a capital budgeting method that compares all relevant costs and benefits between alternative investments or process changes (Causing et al. 1996; Schuette 2003). Under TCA, environmental costs are expanded to include more indirect and intangible costs (personal injury, remedial action costs) for a more complete view of the potential environmental impacts of any given potential investment. Firms can make better investment decisions from TCA.

#### *Stage Tóng Rén (Fellowship, 同人)*



In this hexagram, the upper trigram is ‘heaven’ and the lower trigram is ‘fire’. This resembles people gathering around fire under the sky. This hexagram means people are working together towards a common goal: sustainable development. In modern management view, firms form sustainable supply chain.

In sustainable supply chain, firms will closely manage the upstream component in order to maximize the performance of the triple-bottom line (Pagell, Wu & Wasserman 2010). A truly sustainable supply chain will not harm the natural or social systems but can produce profits for an extended period and customers will want to do business with the members of the truly sustainable supply chain forever (Pagell and Wu 2009).

#### *Stage Tài (Harmony, 泰)*



In this hexagram, the upper trigram is ‘earth’ and the lower trigram is ‘heaven’. There are interaction between heaven and earth as heaven moves up and earth moves down. At this stage, the firm, the environment and the society reach a harmonious state.

Life cycle costing (LCC) looks at a product’s entire value chain from a cost perspective (Bradford 2008). It starts to evaluate full costs (including material, social and environmental costs) from the research and development of the product, its manufacturing, usage by customers and the costs of disposal at the end of the product’s life. By analyzing different costs in the product life cycle, firms can produce new products that are well balanced in the economic, environmental and social requirements. The state of harmonious development can be achieved.

## **Conclusion**

Our planet is not sustainable at the present rate of natural resources consumption and pollution. Firms in China need new tools to assess their harmonious development and to support the national-wide 12<sup>th</sup> Five-Year Plan. China, with more than 5,000 years of history has a complex traditional culture. Western management tools without Chinese characteristics may be difficult to implement in Chinese firms. Yi Jīng has significant influence over Chinese people for the past thousands of years. The Oriental EMA combines the traditional Chinese culture with scientific techniques of the West can motivate Chinese managers to adapt environmental management accounting and for achieving the hard targets in the 12<sup>th</sup> Five-Year Plan of China. This Oriental EMA model is currently at conceptual stage. It is important to test this conceptual model in real working situation and we are going to test this model in practice with Chinese managers.

## References

Bansal, P., & Roth, K. (2000) Why companies go green: A model of ecological responsiveness, *Academy of Management Journal*, 13(4), 717–736.

Birkin, F. (1996) Environmental management accounting, *Management Accounting: Magazine for Chartered Management Accountants*, Vol. 74, Issue 2: 34-8

Bradford T. (2008) *Life-Cycle Costing*, [Online] Available at: <http://tiffany-bradford.suite101.com/lifecycle-costing-a52266> [Accessed 10 March 2012]

Burritt, R.L., Hahn, T. and Schaltegger, S. (2002) Towards a comprehensive framework for environmental management accounting – links between business actors and environmental management accounting tools, *Australian Accounting Review*, Vol. 12 No. 2, pp. 39-50

Causing M., Jensen S., Haynes S. and Marquardt W. (1996) *Analysis of Pollution Prevention Investments Using Total Cost Assessment: A Case Study in the Metal Finishing Industry* [Online] Available at: <http://infohouse.p2ric.org/ref/03/02976.pdf> [Accessed 10 March 2012]

Chen, C. and Lee, Y. (2008), *Leadership and Management in China*, Cambridge University Press, New York, NY

Chanegrih, T. (2008) Applying a typology of management accounting change: a research note, *Management Accounting Research*, 19, pp. 278–285

Chow, L. M.Y., Chau, G. K.K. and Gray, S. J., (1995), Accounting reforms in China: Cultural constraints on implementation and development, *Accounting and Business Research*, Vol. 26, No. 1, pp. 29-49.

Elkington J. (1998) *Cannibals with Forks: The Triple Bottom Line of 21st Century Business*, Stony Creek, CT: New Society Publishers.



Ferreira A., Moulang C., Hendro B., (2010), Environmental management accounting and innovation: an exploratory analysis, *Accounting, Auditing & Accountability Journal*, Vol. 23, Issue 7, pp.920-948

Gale R. (2006) Environmental costs at a Canadian paper mill: a case study of Environmental Management Accounting (EMA), *Journal of Cleaner Production*, 14, 1237-1251

George T. Friedlob and Franklin J. Plewa Jr. (1996) *Understanding balance sheets*, John Wiley & Sons

Hofstede G. H. (2001) *Culture Consequences*, 2<sup>nd</sup> Edition, Sage Publications, Inc., Thousand Oaks, Calif

Hoon-Halbauer S.K. (1999) Managing relationships within Sino-foreign joint ventures, *Journal of World Business*, 34(4), pp. 344–369

IFAC (2005), *International Guidelines on Environmental Management Accounting*, [ONLINE] Available at:  
<http://www.ifac.org/sites/default/files/publications/files/international-guidance-docu-2.pdf> [Accessed 03 March 2012]

Jasch, C. (2003) The use of environment management accounting (EMA) for identifying environmental costs, *Journal of Cleaner Production*, Vol. 11, pp. 667-76

Littleton A. C. (1933) *Accounting Evolution to 1900*, American Institute Publishing Company.

Liu K.C. and Zhang W.G. (1996) *Contemporary Accounting Issues in China: An Analytical Approach*, Englewood Cliffs, NJ: Prentice Hall

MacArthur J. B. (2006) Cultural influence on German versus U.S. management accounting practices, *Management Accounting Quarterly*, Vol. 7, No. 2, p.10-16

Mun K.C. (2007) *Chinese Leadership Wisdom from the Book of Change*, The Chinese University Press

National People's Congress of People's Republic of China (2011) *Report on China's*

*economic, social development plan*, [ONLINE] Available at:  
[http://www.npc.gov.cn/englishnpc/Special\\_11\\_4/2011-03/18/content\\_1647939.htm](http://www.npc.gov.cn/englishnpc/Special_11_4/2011-03/18/content_1647939.htm)  
[Accessed: 10 March 2012]

Pagell M., Wu Z. (2009) Building a more complete theory of sustainable supply chain management using case studies of 10 exemplars, *Journal of Supply Chain Management*, Vol 45, Issue 2, p.37-56

Pagell M., Wu Z. and Wasserman M.E. (2010) Thinking differently about purchasing portfolios: an assessment of sustainable sourcing, *Journal of Supply Chain Management*, Vol 46. Issue 1, p.57-73

Schuette R. (2003) Total Cost Assessment a useful tool for integrating EH&S and risk into decisions for sustainable development, [ONLINE] Available at:  
<http://texasiof.ces.utexas.edu/texasshowcase/pdfs/presentations/a2/rschuette.pdf>  
[Accessed 10 March 2012]

United Nations Division for Sustainable Development (2005) *Environmental management accounting: Procedures and Principles*, [ONLINE] Available at:  
<http://www.un.org/esa/sustdev/publications/proceduresandprinciples.pdf> [Accessed 10 March 2012]

World Commission on Environment and Development (WCED) (1987) *Report of the World Commission on Environment and Development: Our Common Future*, [ONLINE] Available at: <http://www.un-documents.net/wced-ocf.htm> [Accessed 03 March 2012]

WWF (2012) *WWF - Environmental problems in China*, [ONLINE] Available at:  
[http://wwf.panda.org/who\\_we\\_are/wwf\\_offices/china/environmental\\_problems\\_china](http://wwf.panda.org/who_we_are/wwf_offices/china/environmental_problems_china)  
[Accessed 06 March 2012]

Zhou M. (2007) Cultural analysis of the management accounting application in China, *Journal of Modern Accounting and Auditing*, p. 11-16

Zoellick, R.B. (2010) *Democratizing development economics*, [ONLINE] Available at:  
<http://web.worldbank.org/WBSITE/EXTERNAL/NEWS/0,,contentMDK:22716997~pagePK:34370~piPK:42770~theSitePK:4607,00.html> , [Accessed 2 March 2012]

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**Policies to promote environmental responsibility in SMEs: a case-based review**

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Governments around the world are beginning to respond to the complex challenges of sustainable development. Until recently, much of the emphasis of policy-makers was around the 'greening' of larger public and private sector organisations. However, over the last two decades there has been an increasing interest in enhancing the environmental performance of SMEs. Many different policy tools have been introduced in an attempt to control against environmentally damaging economic activity on the part of SMEs, and to encourage them to adopt more environmentally benign ways of operating<sup>1</sup>.

While some of these interventions have proved effective in their own terms, better integrated approaches are now required to address complex and deep-rooted sustainability challenges. It is also necessary to:

- clarify the purpose of each intervention, taking into account potential interactions and trade-offs;
- select appropriate tools based on an informed review of the available options;
- address geographic, sectoral and firm-level characteristics;
- recognise that environmental responsibility is a product of multi-level interactions involving SME owner-managers, their enterprises, and contexts in which they operate.

Environmental policy for SMEs is a vast arena, which extends from relatively modest local conservation projects to ambitious 'green new deals' that span national and regional economies. This paper provides an overview of the main types of policy developed in the last 20 years. Its aims are to:

1. Introduce the main options available to policy-makers seeking to influence the environmental performance of SMEs and entrepreneurial firms;
2. Review available evidence on the effectiveness and impact of specific interventions;
3. Stimulate debate on the framing of future policies in this area.

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<sup>1</sup> See, for example, Parker *et al.* 2009, Parrish and Foxon 2009.

The paper draws primarily on examples of environmental policy-making in European countries, but its arguments have a more general application. The main focus of the paper is on waste management and climate change mitigation, two key environmental policy arenas in which there are significant implications for SMEs. The remainder of the paper is organised as follows. Section 2 considers the context in which policies are framed, arguments presented in support of intervention, and the main policy options. Section 3 examines four case-based examples, analysing their policy context and drivers, summarising the tools selected and evaluating their impact, highlighting potential strengths and limitations. Section 4 discusses the main implications for environmental policy and practice.

## Introduction

Governments around the world are beginning to respond to the complex challenges of sustainable development. Until recently, much of the emphasis of policy-makers was around the 'greening' of larger public and private sector organisations. However, over the last two decades there has been an increasing interest in enhancing the environmental performance of SMEs. Many different policy tools have been introduced in an attempt to control against environmentally damaging economic activity on the part of SMEs, and to encourage them to adopt more environmentally benign ways of operating<sup>2</sup>. This is a vast policy arena, which extends from relatively modest local conservation projects to ambitious 'green new deals' that span national and regional economies. This working paper provides an overview of the main types of policy developed in the last 20 years. Its aims are to:

1. Introduce the main options available to policy-makers seeking to influence the environmental performance of SMEs and entrepreneurial firms;
2. Review available evidence on the effectiveness and impact of specific interventions;
3. Stimulate debate on the framing of future policies in this area.

The paper is international in scope, but given limitations of space, several linked examples are drawn from European countries. For similar reasons, much of the discussion focuses on two key environmental policy areas, waste management and climate change mitigation. The remainder of the paper is organised as follows. Section 2 considers the context in which policies are framed, arguments presented in support of intervention, and the main policy options. Section 3 takes a closer look at four case-based examples, highlighting potential strengths and limitations. Section 4 discusses the main policy implications.

## 2 Policy context and options

### 2.1 The case for intervention

SMEs have a substantial environmental impact. Its nature and scale can be illustrated by the findings of a recent study conducted by European researchers (Calogirou *et al.* 2010). They calculate that SMEs are responsible for 64% of the overall environmental impact in Europe, including greenhouse gas emissions (Figure 1)<sup>3</sup>. SMEs are important because they account for

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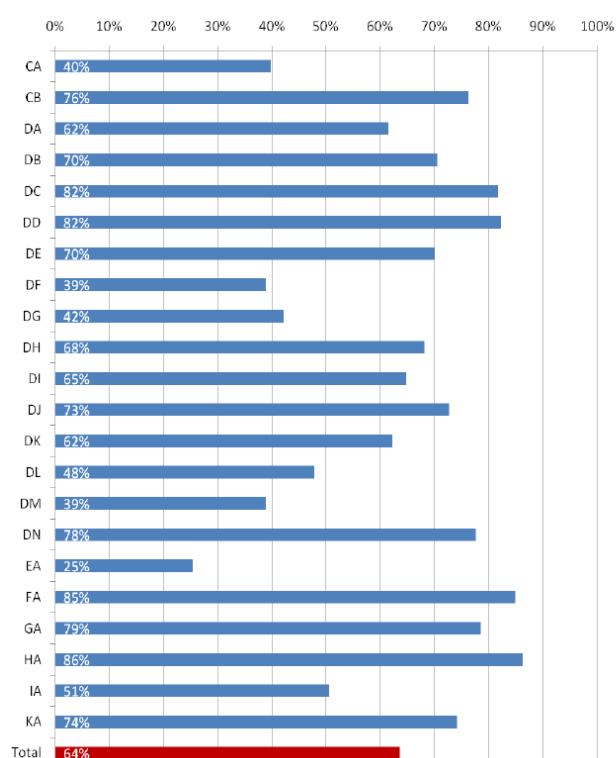
<sup>2</sup> See, for example, Parker *et al.* 2009, Parrish and Foxon 2009.

<sup>3</sup> Many other environmental impact measures could be examined here. Taking the UK as an example: SMEs account for approximately 45 per cent of total UK business energy use, broadly in proportion to their share of the economy (Vickers *et al.* 2009); almost a third of SME expenditure on energy (i.e. approximately £1.1 billion per annum) is wasted through inefficient practices (BERR, 2008 – citing Carbon Trust 2006); SMEs also cause about 43 per cent of serious industrial pollution incidents and generate 60 per cent of commercial waste in England and Wales, which is itself an important source of 'embedded' emissions of greenhouse gases (Environment Agency, 2006: 11; House of Lords, 2008).

such a large percentage of economic activity, and of the resulting pressures placed on our planet's finite resources. Though some impacts, such as energy use, are roughly related to their share of the economy, smaller firms can have disproportionate impacts in some sectors. One reason is that they are often more difficult to regulate than their larger counterparts. In addition, they may lack knowledge and other resources needed to respond effectively.

Governments have committed to a variety of environmental goals that relate to SMEs. Perhaps the most dramatic of these is in the field of climate change mitigation, where public policies call for businesses, including SMEs, to make substantial reductions in emissions of carbon dioxide and other 'greenhouse' gases. For example, in 2011 the European Council reconfirmed the EU's objective of reducing greenhouse gas emissions by 80-95% by 2050 compared to 1990. The EU has developed a 'roadmap' setting out what it regards as a cost-effective route for transforming Europe into a competitive 'low-carbon' economy. This plan involves intermediate cuts in emissions of 25% (by 2020), 40% (by 2030) and 60% (by 2040) (European Union 2010).

Figure 1: The average environmental impact from SMEs in the EU27 per sector



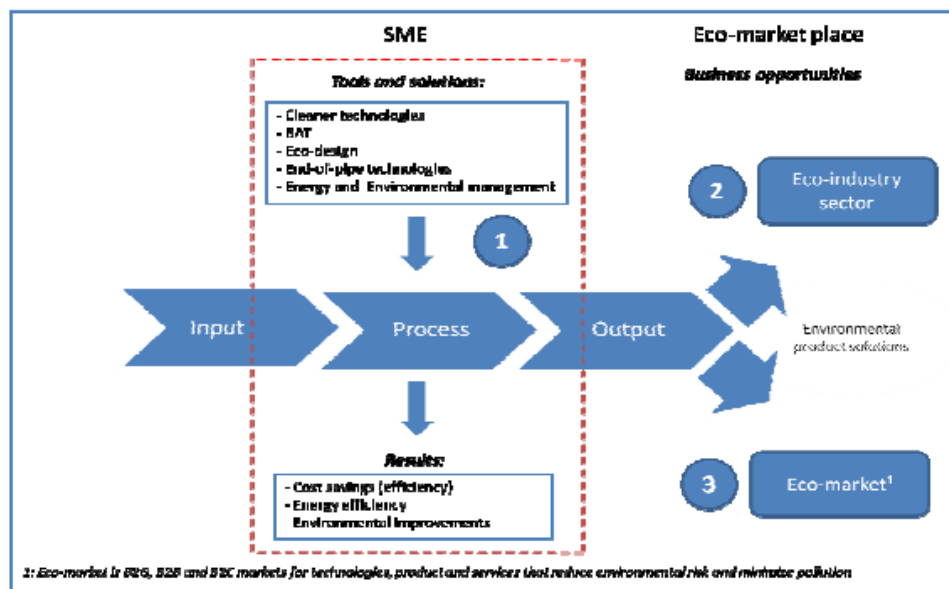
Source: Calogirou *et al.* 2010: 60 (Table 31). SBS and environmental data from Eurostat, 2006 and DTI estimations for the EU27. Aggregated at level 3 data, NACE subdivision level (equals the average share of employees in the SME size companies per country).

Arguments for intervention can be categorised using the conventional distinction between SME policies and entrepreneurship policies (e.g. Audretsch and Beckman 2007). SME policies tend to be justified on the grounds that they address perceived obstacles faced by existing organisations. For example, one of the main arguments for intervention is that smaller firms have been slower to adopt environmental improvements than their larger counterparts; research evidence suggests that this is due to a combination of internal and external barriers (Vickers *et al.* 2009: 4). This reflects the traditional focus of SME policies on overcoming barriers and countering perceived disadvantages of SMEs in relation to larger and more established businesses. SME policies have tended to focus on 'business case' for sustainability, and on the 'win-win' arguments of eco-

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efficiency generating cost savings at a firm level. By contrast, entrepreneurship policies tend to be oriented towards with the promotion of innovative technologies and practices within an emerging 'green' market economy. They have also tended to emphasise conventional economic imperatives, such as enhancing competitive advantage, increasing employment opportunities and achieving economic growth (Hall *et al.* 2010), with environmental gains providing a secondary benefit. For example, encouraging environmental technology start-ups could help to transform the industrial base of a region, enabling it to become more competitive in international markets (UNEP 2009). Figure 2 summarises these cost-saving and opportunity-based arguments.

Figure 2: Cost reductions and green business opportunities for SMEs



Source: Calogirou *et al.* 2010: 138 (Figure 6)

## 2.2 Environmental policies: focus and aims

So where should governments focus their attention and resources? The European Environmental Agency recently identified six 'key' areas of environmental policy (i.e. climate change mitigation; climate change adaptation; biodiversity; water; air; waste) and five 'key' cross-sectoral policies that have particular environmental impacts (i.e. transport; energy; agriculture; fisheries; structural funds) (European Environmental Agency 2010a). While these categorisations are useful for agenda-setting purposes, policy makers still face major challenges in reconciling distinct and potentially conflicting agendas. In relation to SMEs and entrepreneurship, the broad aims of environmental policies include: (1) helping smaller firms to meet governmental targets (e.g. reducing greenhouse gas emissions); (2) enabling larger firms and the public sector to source from environmentally-sustainable suppliers; and (3) ensuring that SMEs are well-positioned to take up the opportunities of a greener, low carbon economy. The interface between environmental and enterprise policies is illustrated by the European Union's 2020 plan, which has a number of aims related to 'sustainable growth' including: 'building a competitive low-carbon economy that makes efficient, sustainable use of resources'; 'protecting the environment and preventing biodiversity loss'; and 'capitalising on Europe's leadership in developing new green technologies and production methods' (European Commission 2011).

## 2.3 Policy options and institutional contexts

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Policy makers are confronted with many options for improving environmental outcomes, involving different uses of economic, regulatory, and support-based tools. This section analyses these broad categories and outlines the kinds of choices open to them. For example, the challenge of climate change has prompted European governments to introduce more than 1,200 different measures to date, with a particular emphasis on economic instruments and regulation (Table 1). While the number and distribution of tools is bound to vary across different areas of environmental policy-making, this illustrates the range of options available.

In selecting particular measures, there are a number of questions to consider. For example, policy makers can select tools that are designed to act at various levels (e.g. individual entrepreneurs, firms, supply-chains, industrial sectors, geographic regions). They may address particular areas of business strategy and operations (e.g. procurement, product design, production, distribution). Selection criteria are likely to be influenced by a number of factors, including: (i) emphasis given to particular issues (e.g. energy efficiency is now seen as an important element in climate change mitigation); (ii) specific characteristics of the individuals, firms and sector(s) being addressed<sup>4</sup>; (iii) broader contextual factors (e.g. political and economic systems, physical infrastructure, educational attainment). As a consequence, policy choices are likely to vary by country and region. For example, while some governments might have a preference for regulation, the most common carbon reduction strategies in Canada are based on financial incentives and awareness-raising, with rebates for energy efficiency retrofits undertaken by SMEs (Burch *et al.*, 2011: 1; NRC, 2011). These differences in approach, and the ways that policies evolve over time, can be illustrated with reference to waste management. Early policies focused on public health, and subsequently on protecting the environment through pollution controls<sup>5</sup>. SMEs are now confronted by a complex and often confusing array of regulations and fiscal incentives. From the 1990s, efforts have increasingly focused on waste prevention and recycling. Policy tools adopted for this purpose include setting targets for local authorities, communications campaigns, and measures to stimulate growth in markets for recovered materials. Waste is a global problem, and innovative approaches can be found around the world (see: Cases A and B below). For example, Hong Kong combines waste charging to change consumption and disposal behaviours, with public education initiatives, support for the recycling industry and a 'Wastewi\$e' award and labelling scheme for local businesses (GovHK 2011). Fiscal measures are also popular, with some countries, including Switzerland combining free recycling facilities with high charges for waste disposal.

Table 1: Main focus of climate policy making

<i>Type of measure</i>	<i>Number of citations</i>
Economic	371
Regulatory	342
Information	182
Fiscal	119
Voluntary	80
Planning	76
Education	49
Research	39

Source: European Environmental Agency (2010b)

<sup>4</sup> The promotion of 'eco-industries' is dealt with in the following section.

Eco-industries are often seen as a special case in policy terms. They are formally defined by the OECD and Eurostat as, 'activities which produce goods and services to measure, prevent, limit, minimize or correct environmental damage to water, air and soil, as well as problems related to waste, noise and eco- systems. They incorporate technologies, products and services that reduce environmental risk and minimize pollution, and include firms operating in sectors such as:

- Air pollution and control
- Waste management
- Soil remediation
- Noise and vibration control
- Waste and waste water treatment
- Environmental monitoring
- Renewable energy sources (e.g. wind and wave power generation)
- Eco-construction
- Clean technologies and processes
- Environmental consulting

For these cases, conventional enterprise policy tools may be deployed in an effort to promote the growth of individual firms, or for sectoral development (see: Cases C and D below).

In summary, it is unlikely that any one policy will act as a 'magic bullet'. Rather, the overall approach adopted, including the tools used and the ways they are combined, is likely to differ according to circumstances. Due to this inherent complexity, and the lack of rigorous data on impacts and outcomes, it is not possible to make straightforward assessments of the relative strengths and limitations of particular tools. In the next section we present four cases of environmental policy-making to indicate how tools have been selected and combined in practice. Each case has unique features, but it is possible to draw some broader lessons, and to identify tools and approaches that can be more readily adapted and translated to other settings.

### 3 Policy tools in practice

#### 3.1 Introducing the four cases

The cases are presented the following common format to provide for cross-case comparison: (i) introduces the context in which the policy was formulated identifies relevant policy drivers (ii) specifies the tool, or combination of tools, selected to achieve a particular set of goals; (iii) evaluates the outputs, immediate impact and longer-term outcomes of the policy (Table 2):

Table 2: Policy tools in practice - four case illustrations

<i>Case</i>	<i>Details</i>	<i>Policy tools deployed</i>
A	<b>Encouraging anaerobic digestion of organic waste</b> (UK)	Fiscal Regulatory
B	<b>Creating web-based waste management support services</b> (Germany/UK)	Information Education
C	<b>Promoting wind energy innovation and entrepreneurship</b> (Denmark/USA)	Fiscal Regulatory Research

*Paper presented at Track 4b: Markets, Institutions and Frameworks for Eco-Innovation, 18<sup>th</sup> Annual International Sustainable Development Research Conference, University of Hull, 24-26 June 2012.*



		Voluntary
D	<b>The 'roof transition'- a case of policy entrepreneurship?</b> (The Netherlands)	Voluntary Research

*Case A: Financial incentives – anaerobic digestion of organic waste (UK)*

- i. **Context and drivers:** There has been growing pressure on local authorities and waste management companies to reduce the amount of biodegradable waste, including garden and food waste from households and businesses, sent landfill. There are also pressures to reduce reliance on energy generated from burning fossil fuels. The UK's Department for Environment Food and Rural Affairs signalled the Government's commitment to AD becoming an established technology, 'for treating organic waste, particularly food waste' (Defra 2009). The UK has seen considerable growth in the anaerobic digestion (AD)<sup>6</sup> of food waste, from just 10 plants in 2008 to around 50 in 2010 (Schiller and Thomas 2008, AFOR 2011a). The majority of businesses involved in this process are SMEs.
- ii. **Tools and goals:** Two distinct fiscal measures were put in place to support the development of AD. Firstly, in April 2009, a £10 million funding package was announced to support new composting and AD facilities. Secondly, as a result of changes introduced by the Energy Act 2008, AD technologies will be amongst those receiving additional support in the form of two Renewable Obligation Certificates (ROCs)<sup>7</sup> (Defra 2009a). In addition to these financial incentives, other kinds of policy tool are influencing AD adoption. Regulatory targets were set by UK governments in order to comply with the EU Landfill Directive (EU 1999), and reinforced by the fiscal penalty of a landfill tax charged on every tonne of waste sent to landfill. These measures encouraged the collection and recycling of suitable waste materials. Without them, there would be insufficient feedstock (i.e. source material) for the growing number of digesters. In 2010, 173 local authorities were collecting food waste separately for recycling (AFOR 2011b), whereas only 6 were in 2000 (Brook Lyndhurst 2009).
- iii. **Evaluation:** The intervention appears to have been successful, with the recent rapid growth in AD businesses being attributed, at least in part, to the financial incentive of 'double ROCs', which are encouraging many SMEs to invest in the technology. As one manager commented, 'I think it's the double ROCs that are driving it – people are getting excited about this.'<sup>8</sup> However, the policy landscape is rather more complex. The 'pull' applied by fiscal tools needs to be seen in the context of the broader regulatory 'push' to divert organic wastes from landfill and the increasing awareness of climate change mitigation. AD was also presented as a technology that could deliver positive benefits in reducing greenhouse gas emissions: digesting one tonne of food waste anaerobically, rather than sending it to landfill, is estimated to save between 0.5 and 1 tonne of CO<sub>2</sub> equivalent (Defra 2009b).

*Case B: Information and advice – web-based waste management support (UK/Germany)*

- i. **Context and drivers:** Government agencies and third sector organisations have a long history of supporting SMEs by providing information and advice on waste management issues. This

<sup>6</sup> Anaerobic Digestion is the process where plant and animal material is converted by micro-organisms in the absence of air to release a biogas, comprising mainly of methane, and a digestate, which is rich in nutrients and can be used as fertiliser.

<sup>7</sup> The Renewables Obligation is the main support scheme for renewable electricity projects in the UK. ROCs are issued to accredited generators of eligible renewable electricity generated within the UK and supplied to UK-based customers. ROCs place an obligation on UK electricity suppliers to source an increasing proportion of their electricity from renewable sources; their tradability provides income for renewable electricity generators.

<sup>8</sup> Telephone interview with a manager in an SME involved in waste management and composting and now moving into AD.

includes giving guidance on compliance with regulations and highlighting opportunities to reduce and recycle waste. The growth of the internet, and associated web-based applications, has created new possibilities for engaging with SMEs.

- ii. **Tools and goals:** In the UK, environmental agencies have supported *NetRegs*, an online to provide clear and concise information on legal compliance and environmental good practice. It aims to reduce the amount of environmental harm caused by SMEs. The German national waste prevention plan also seeks to support and encourage pro-environmental actions through an online database, which facilitates coordination and networking. This includes areas such as eco-design, where the database highlights measures that support SMEs developing environmentally-friendly products. A consulting programme in Hamburg is showcased, where firms receive advice from industrial designers and product engineers (ETAP 2011).
- iii. **Evaluation:** Penetration of information-based support services has often been limited<sup>9</sup>. UK research also showed an underlying issue regarding perceptions of environmental impact: before prompting, only 7% of businesses believed that they undertook any activities that could harm the environment (EA 2009). The ability to convert pro-environmental attitudes into operational changes has been identified as a key obstacle (Tilley 1999, Schaper 2002, Revell and Blackburn 2007). The lack of cohesion in provision of recycling services in the UK may also be a contributory factor, with each SME having separate contracts with different waste management companies<sup>10</sup>. Evaluating waste prevention requires assumptions about, 'the kind and amount of waste would have been generated without the measure' (Dehoust *et al.* 2011: 8). The study also found networking was a key requirement: 'Often there is a lack of opportunities to exchange experiences between stakeholders (producers, retailers, consumers, government, etc.) in order to realize possible learning effects. For the policymakers structures such as the Swedish Waste Council, enabling its participants to exchange experiences in the areas of waste prevention and resource management would also be desirable.' (*ibid.*: 18).

#### *Case C: Promoting wind energy innovation and entrepreneurship (USA/Denmark)*

- i. **Context and drivers:** With its large coastline, strong prevailing winds and lack of alternative sources of energy, Denmark was well-positioned to develop wind energy. Simple wind turbines had been used in Denmark in the early 20th century, but today's three-blade turbine originates from a design by Johannes Juul, which operated between 1956 and 1967. Juul's ideas were revived in the early 1970s, when the global oil crisis led politicians and others to seek alternative sources of energy. Danish wind turbine pioneers included a number of self-builders, including amateur enthusiasts and grassroots opponents of nuclear power. Their work was promoted by the magazine *Naturlig Energie* and by the Danish Windmill Owners Association, both of which were founded in the late 1970s (Gipe 1995: 59). The United States also had a long track record in wind energy generation, combined with immense technological expertise and manufacturing capacity.
- ii. **Tools and goals:** The Danish government founded a small wind turbine testing station at Roskilde, and also intervened to subsidise and regulate the emerging industry. At this point Vestas, a small manufacturer of farm equipment and cranes, decided to develop wind turbines. In 1979, the firm signed a licensing agreement with a self-builder, Karl Erik Jørgensen, to produce one of his new designs. Meanwhile, policy-makers in the United States identified the aerospace industry as the obvious source of expertise on turbine design (Gipe 1995: 56, 83-86).

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<sup>9</sup> In the case of *NetRegs*, a recent survey indicated that only 5% of SMEs had heard of the site (EA 2009). Levels of awareness were low but improving: in 2003 only 18% respondents was able to name any piece of environmental legislation unprompted; six years later, the figure had risen to 23% (EA 2003, 2009).

<sup>10</sup> In the UK there is an intention to encourage local authorities to provide adequate recycling facilities for SMEs, either through direct service delivery or by facilitation (Defra, 2009c). The report cites evidence that recycling rates on industrial estates and business parks could be improved, offering significant environmental and economic benefits.

Government intervention in the United States also took the form of fiscal measures, notably tax credits that were made available for wind farm construction projects.

- iii. **Evaluation:** While US engineers concentrated on perfecting the aerodynamic qualities of their designs, their Danish counterparts focused on reliability. Danish designers were in more regular contact with the user community, which comprised mainly small independents and co-operatives, sharing their ideas through regular 'wind meetings'. Geographic proximity, varied site conditions and a spirit of open experimentation helped generate a rapid pace of learning, based on practical experience in the field. Danish designers were responsible for several key innovations, including glass fibre blades, which had their origins in boat building. Despite changes of government, the political coalition around wind energy was sufficient to 'steer' the industry towards maturity, with a gradual reduction in subsidies in the decade to 1989 (Garud and Karnøe 2003: 293). By contrast, fiscal incentives in the US encouraged a speculative boom, with installations being constructed in order to obtain tax breaks rather than to generate electricity (Asmus 2000: 116). There was a dramatic collapse in the mid-1980s when tax credits were withdrawn, with financial failures, expensive lawsuits and many turbines left rusting and unused (Gipe 1995, Asmus 2000: 122)<sup>11</sup>.

*Case D: The 'roof transition' – a case of policy entrepreneurship? (The Netherlands)*

- i. **Context and drivers:** Systems thinking is now used to promote policies for sustainable production and consumption in countries such as Austria, Belgium and Finland (Geels *et al.*, 2008). Much greater integration of environmental, innovation and enterprise policies is necessary because environmental impacts can only be understood with reference to the wider system (e.g. energy, transport etc.). It is only at this level that new configurations of social and technological innovations can generate the radical change (or transition) required to address deeply-rooted and pervasive environmental challenges. The approach is most fully developed in the Netherlands, under the label of 'transitions management' (TM). Initially a policy experiment, TM has evolved since 2002 into a substantial programme to promote transition towards a more sustainable energy system by 2050. The 'rooftop transition' (Loorbach and Rotmans 2010: 240-241), illustrates how a transition initiative can be driven by independent entrepreneurial activity.
- ii. **Tools and goals:** TM policies typically combine two dimensions: (i) increase pressure on the existing system through mechanisms such as financial and regulatory measures; (ii) stimulating and supporting the emergence and development of new '*niches*' (*i.e. protected environments* where new concepts and radical innovations can be developed). Success in the first dimension should create windows of opportunity for diffusion and mainstreaming of niche innovations. The 'roof transition' was prompted by the need to reconsider bitumen's traditional use as a roof coating. In 2007, the CEO of EHSA, a manufacturer of bituminous products, began to formulate a strategy to transform roofs into products that could contribute to sustainable energy, efficiency and CO<sub>2</sub> reductions within 10-15 years. Recognising that a fundamental change would be necessary to realise this vision, the CEO established an innovative niche called the 'Earth Recovery Open Platform' (EROP). EROP involved a range of stakeholders, 'municipalities, local water boards, large manufactures of roofing products, knowledge institutes, companies where implementation was envisaged, environmental NGOs, architects, urban planners and energy companies' (Loorbach and Rotmans 2010: 240). EROP developed a range of visions for the future role of roofs, reframing them as energy producers, heat repositories, air cleaners and building coolers. Based on these visions – all explicitly linked to persistent societal problems such as poor air quality in urban areas and energy dependency – a number of 'roof development companies' were established. Their role is to identify roofs that could be developed to contribute

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<sup>11</sup> The wind power generation industry in the US has since recovered much of its momentum. The US has the world's second largest installed capacity after China, and the Department of Energy has an ambitious strategy to develop offshore wind generation (DoE 2011).

to sustainability while also creating extra value for municipalities. EROP is now at the experimentation stage (e.g. developing green roofs in Rotterdam). In 2008, ESHA opened the first 100% bitumen-recycling plant and is developing of new CO<sub>2</sub>-extensive roofing equipment.

- iii. **Evaluation:** Given the experimental nature of innovation niches and the fundamental sectoral change required, it is no surprise that ESHA has yet to make a substantial return on its investment. While roof producers have collaborated, there has been significant competition over specific technologies and practices. This is compounded by other barriers to mainstreaming the 'roof transition', including existing regulations (e.g. roofs cannot currently be leased or treated as energy production facilities) and economic factors (i.e. the social value of the transition has not been translated into monetary terms) (Loorbach *et al.* 2010). The main achievement has been in creating a vision and agenda that has been adopted by the sector and by national government. 'By strategically tuning into the current political debate and favourable climate for sustainability in the Netherlands, the 'roof transition' has been adopted by national policy as one of the central innovation programs for the built environment and the norms developed within EROP have been adopted as national policy' (Loorbach and Rotmans 2010: 241).

## 4 Discussion: the way forward?

### 4.1 Lessons from the cases

The four cases illustrate some of the different ways that policy tools have been combined in order to improve environmental performance. The different outcomes can be explained by a combination of factors, including the choice of policy tools, the context in which they were applied, and the response of non-governmental actors, including local communities and large corporations. Historical influences often play an important role, as indicated in Case C. Researchers studying wind energy in the German state of North Rhine-Westphalia (NRW) and the Netherlands also found initial differences in public policies influencing subsequent entrepreneurship patterns (Agterbosch and Breukers 2008: 645)<sup>12</sup>.

### 4.2 The case for better integrated policies

Governments have often been encouraged to develop more coherent and integrated enterprise policies (e.g. Audretsch and Beckman, 2007). Similar calls are being heard in relation to environmental policies, with environmental campaigners, industry bodies and entrepreneurs expressing similar views, especially in relation to global environmental issues. For example, in their recent report, 'Seizing the Sustainability Advantage' leading Australian firms in the built and natural environment sectors voiced their concerns about national and state policies:

'Australian governments' fragmented responses to climate change, and diluted incentives towards achieving a sustainable built and natural environment, reduce our competitive advantage in the global economy and increase the risks to which the Australian community are now exposed.' (Consult Australia 2011: 4)

In Case B, we saw how different tools might be combined in support of a particular policy goal. The German government's researchers identified one of the important objectives of a national waste prevention programme as creating, 'a strategic reference framework', capable of coordinating actions at the federal, state and municipal level. The authors saw a common approach as

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<sup>12</sup> As in Denmark, federal and state-level policies encouraged grassroots initiatives in the early years, with farmers and small, community-owned projects being given access to the electricity grid via preferential 'feed-in' tariffs (ibid. 639). After the mid-1990s, many of these locally-owned initiatives were displaced by larger organisations. However, these earlier developments played an important role in helping wind energy to gain social acceptance, so accelerating the growth of the industry in this region.

generating significant synergies between the different individual projects (Dehoust *et al.* 2011: 18)<sup>13</sup>. Case D showed how coordinated interaction is also central to the transitions management approach, though governments do not always need to take the lead.

It seems increasingly likely that policy-makers will need to seek new solutions, including the use of entrepreneurial actors, in order to facilitate the kinds of sustainability transitions that are now needed. In some countries, a preference for independent entrepreneurial action over direct state intervention may reflect prevailing political and social values. However, with continuing dislocation in the global economy, and with many national governments operating under increasingly severe fiscal constraints, there is a more generalised requirement to consider alternative options. These policy innovations will necessitate a more active engagement with innovators and entrepreneurs, ensuring that a diverse range of voices is heard, and not simply that of incumbent interests. With new combinations of actors, fresh perspectives, and more effective vehicles for collaboration, it may be possible to achieve make real progress towards a more sustainable future (Blundel and Monaghan 2009, Loorbach and Rotmans 2010, Smith *et al.* 2005).

### 4.3 Refining the research agenda

We conclude this paper by considering some implications of the preceding arguments for entrepreneurship research. Perhaps the most important research contribution would be in examining the heterogeneity of the entrepreneurial actors involved, and drawing out the implications for policy. For example, it would be naive to assume that all actors respond in similar ways to specific interventions. Impacts and outcomes are likely to vary for different types (e.g. in relation to age, sector, social or commercial orientation). This suggests at least two research themes: firstly, reviewing the existing literature on policy intervention; secondly, mapping some of the emerging configurations of entrepreneurial actors. While such research is likely to require close attention to specific sustainability transition contexts, it could prove invaluable in guiding future enterprise policies in a more sustainable direction.

## References

AFOR (2011) UK bins 10 Wembleys full of food a year. Wellingborough: Association for Organics Recycling. Available at: [www.organics-recycling.org.uk/](http://www.organics-recycling.org.uk/) (accessed 9 March 2011).

Audretsch, D.B., and Beckmann, I.A.M. (2007) From small business to entrepreneurship policy. In

Audretsch, D.B., Grilo, I. and Thurik, A.R. (eds.) (2007) *Handbook of research in entrepreneurship policy*. Cheltenham: Edward Elgar (36-53).

Blackburn, R. and Ram, M. (2006) Fix or fixation?: the contributions and limitations of entrepreneurship and small firms to combating social exclusion. *Entrepreneurship and Regional Development*, 18, 1: 73-89.

Blundel, RK, and Monaghan, A (2009) Ships passing in the night?: re-thinking the relationship between entrepreneurial agency and purposive transitions. *1st European Conference on Sustainability Transitions: 'Dynamics and Governance of Transitions to Sustainability'*. KSI, Amsterdam, 4-5 June.

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<sup>13</sup> Business representatives in Australia have made a broadly similar recommendation, with proposals for a 'Commission for a Sustainable Australia', capable of driving 'innovation and new technology pathways for a sustainable future'; a National Sustainability Framework; and a National Adaptation Plan for Action (Consult Australia 2011: 9).

Brook Lyndhurst (2009) *Enhancing participation in kitchen waste collections: final project report for Defra Waste and Resources Evidence Programme (WR0209)* Available at: <http://www.defra.gov.uk> (accessed 19 March 2011).

Burch, C., Shaw, A., Zerriffi, H. and Meyer, R. (2011) *Harnessing the entrepreneurial power of small business: New strategies for reducing greenhouse gas emissions (briefing note 2011-28)*. University of Victoria: Pacific Institute for Climate Solutions.

Calogirou C., Sørensen, S.Y., Bjørn Larsen, P., Alexopoulou, S. *et al.* (2010) *SMEs and the environment in the European Union*. Brussels: PLANET SA and Danish Technological Institute for European Commission, DG Enterprise and Industry. Available at: <http://ec.europa.eu/enterprise/policies/sme/business-environment/> (accessed 9 March 2011).

CE and AEAT (2003) *The benefits of greener business*. Cambridge Econometrics and AEA Technology ([www.environment-agency.gov.uk/business](http://www.environment-agency.gov.uk/business)).

Consult Australia (2011) *Seizing the sustainability advantage*. Sydney: Consult Australia. Available at: <http://www.consultaustralia.com.au> (accessed: 19 March 2011).

Dehoust, G., Küppers, P., Bringezu, S. and Wilts, H. (2011) *Development of scientific and technical foundations for a national waste prevention programme (summary)*. (UBA-FB) 0014427/E. Öko Institut e.V., Darmstadt. Available at: <http://www.uba.de/uba-info-medien-e/4044.html> (accessed 19 March 2011).

Defra (2009a) *Waste strategy: Annual progress report 2008/09*. London: Department for Environment, Food and Rural Affairs

Defra (2009b) *Anaerobic digestion – shared goals*. London: Department for the Environment, Food and Rural Affairs.

Defra (2009c) *Commercial and industrial waste in England*. London: Department for the Environment, Food and Rural Affairs.

DoE (2011) *A National offshore wind strategy: Creating an offshore wind energy industry in the United States*. Washington DC: Department of Energy.

EA (2003) *SME-nvironment 2003: A survey to assess environmental behaviours among smaller UK businesses*. London: Environment Agency. Available at: [www.netregs.gov.uk](http://www.netregs.gov.uk) (accessed 9 March 2011).

EA (2009) *SME-nvironment 2009: UK Summary*. London: NetRegs, Environment Agency, NIEA and SEPA. Available at: [www.netregs.gov.uk](http://www.netregs.gov.uk) (accessed 9 March 2011).

ETAP (2011) *Germany: Laying the foundations for a German national waste-prevention plan*. Brussels: Environmental Technologies Action Plan, European Commission. Available at: [http://ec.europa.eu/environment/etap/inaction/showcases/germany/642\\_en.html](http://ec.europa.eu/environment/etap/inaction/showcases/germany/642_en.html) (accessed 9 March 2011).

European Environmental Agency (2010a) *The European environment - state and outlook 2010: SOER 2010 in a policy context*. Copenhagen: European Environmental Agency. Available at: [www.eea.europa.eu/soer/policy-makers](http://www.eea.europa.eu/soer/policy-makers) (accessed 9 March 2011).

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European Environmental Agency (2010b): *Climate policies and measures in Europe*. Copenhagen: European Environmental Agency. Available at: [www.eea.europa.eu/themes/climate/pam/](http://www.eea.europa.eu/themes/climate/pam/) (accessed 9 March 2011).

European Commission (2011) A resource-efficient Europe – Flagship initiative under the Europe 2020 Strategy. COM(2011) 21. Brussels: European Commission. Available at: [http://ec.europa.eu/resource-efficient-europe/pdf/resource-efficient\\_europe\\_en.pdf](http://ec.europa.eu/resource-efficient-europe/pdf/resource-efficient_europe_en.pdf) (accessed 9 March 2011).

Geels, F.W., Monaghan, A., Eames, M. and Steward, F. (2008) *The feasibility of systems thinking in sustainable consumption and production policy*. Department for Environment, Food and Rural Affairs: London. Available at: [http://randd.defra.gov.uk/Document.aspx?Document=EV02030\\_7726\\_FRP.pdf](http://randd.defra.gov.uk/Document.aspx?Document=EV02030_7726_FRP.pdf) (accessed 28 March 2011).

Girard, M. (2006) *Success factors for small medium enterprise (SME) engagement in greenhouse gas markets*. Mississauga: Canadian Standards Association.

GovHK (2011) *Waste reduction and recycling*. Available at: <http://www.gov.hk/en/residents/environment/waste/wasteredrecyc.htm> (Accessed 29 March 2011).

Hall, J.K., Daneke, G.A. and Lenox, M.J. (2010) Sustainable development and entrepreneurship: past contributions and future directions. *Journal of Business Venturing*, 25, 5: 439-448.

Hoogma, R., Weber, K.M. and Elzen, B. (2005) Integrated long-term strategies to induce regime shifts towards sustainability: The approach of strategic niche management.' In Weber, M. And Hemmelskamp, J. (eds.) *Towards environmental innovation systems*. Berlin: Springer Verlag (209 236).

Loorbach, D. and Rotmans, J. (2010). The practice of transition management: Examples and lessons from four distinct cases. *Futures*, 42, 3: 237-246.

Loorbach, D., van Bakel, J.C., Whiteman, G. and Rotmans, J. (2010) Business strategies for transitions towards sustainability. *Business, Strategy and the Environment*, 19, 2: 133-146.

Monaghan, A. (2009) Conceptual niche management of grassroots innovation for sustainability: The case of body disposal practices in the UK. *Technological Forecasting and Social Change*, 76, 8: 1026-1043.

NRC (2011) *EcoENERGY Retrofit Grants and Incentives*. Natural Resources Canada. Available at: <http://oee.nrcan.gc.ca/corporate/retrofit-summary.cfm?attr=0> (accessed 19 March 2011).

Parker, C.M., Redmond, J. and Simpson, M. (2009) A review of interventions to encourage SMEs to make environmental improvements. *Environment and Planning C: Government and Policy*, 27, 2: 279-301.

Parry, S. (2009) The greening of rural Cumbrian micro-businesses. *Institute for Small Business and Entrepreneurship Conference*. Liverpool, 3-6 November.

Revell, A. and Blackburn, R. (2007) The business case for sustainability?: An examination of small firms in the UK's construction and restaurant sectors. *Business Strategy and the Environment*, 16, 6: 404-420.

*Paper presented at Track 4b: Markets, Institutions and Frameworks for Eco-Innovation, 18<sup>th</sup> Annual International Sustainable Development Research Conference, University of Hull, 24-26 June 2012.*



Schaper, M. (2002) Small firms and environmental management. *International Small Business Journal*, 20, 3: 235-251.

Smith, A., Stirling, A. and Berkhout, F. (2005) The governance of sustainable socio-technical transitions. *Research Policy*, 34: 1491-1510.

Stevenson, L. and Lundström, A. (2002) *Beyond the rhetoric: Defining entrepreneurship policy and its best practice components*. Stockholm: Swedish Foundation for Small Business Research.

Tilley, F. (1999) The gap between the environmental attitudes and the environmental behaviour of small firms. *Business Strategy and the Environment*, 8, 4: 238-248.

UNEP (2009) *An introduction to the Green Economy report*. Geneva: United Nations Environment Programme / Green Economy Initiative.

Vickers, I., Vaze, P., Corr, L., Kasparova, E. and Lyon, F. (2009) *SMEs in a low carbon economy* (URN 09/574). London: CEEDR, Middlesex University. Available at: [www.berr.gov.uk/files/file49761.doc](http://www.berr.gov.uk/files/file49761.doc) (accessed: 9 March 2011).



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*Track 4b: Markets, Institutions and Frameworks for Eco-innovation*

**Eco-innovation opportunities in the waste management sector in Scotland**

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**Abstract**

Scotland is currently experiencing a strong shift in waste policy, driven by climate change goals aimed at significantly reducing waste to landfill and maximising material resource efficiency. Despite strong policy ambitions, the growth in the waste recovery sector in Scotland has been relatively slow. This paper provides an overview of the waste management (WM) sector in Scotland, and presents findings of a 3 year project with small and medium sized enterprises (SMEs) in both waste and non-waste sectors on improving resource efficiency and identifying opportunities for industrial symbiosis. The outcomes of the project highlighted a number of key barriers and opportunities to improve resource management. In particular eco-innovation is required at many levels in order to allow capacity building for recycling services and end markets for recycle. Conclusions are drawn on the importance of the role of eco-innovation in SMEs when responding to opportunities derived from changing policy frameworks and legislation.

**1 Introduction:**

Over the past several decades, efforts to stimulate growth in the recycling sector have generally been associated with increasing diversion of waste from landfill through public awareness raising, improved public collection schemes or regulatory instruments such as landfill taxes. However, while the supply of recycle has increased, the capacity to process materials within Scotland has not fully developed. Faced with landfill diversion targets from the EU, and strict targets under Scotland’s Zero Waste Plan (ZWP), a need to shift away from simply managing waste, to a system of managing resources will be required. Closing resource loops in Scotland remains challenging with large quantities of recycle being exported out of Scotland and often out of the UK. Eco-Innovation therefore has a role in providing solutions to material resource leakage from Scotland.

This paper provides a brief overview of the waste management (WM) sector in Scotland comparing levels of growth in waste recycling and reprocessing activities to growth in waste collection activities from 2005 to 2011. Reviewing information collected in the ACE Eco-Partnerships (AEP) project carried out at University of Abertay Dundee

between 2009 and 2011 along with relevant literature, we consider the factors impacting the development of indigenous markets for reprocessed materials, and recommendations for reducing large material flows of recovered materials out of Scotland.

## 2 Waste Sector Review

At an EU level, the primary driver for improved WM over the last 2 decades has been the EU Landfill Directive with technical requirements for landfills and targets for diversion of biodegradable municipal waste (BMW) from landfill by 2020. This has driven measures in the UK such as the Landfill Tax Escalator and Local Authority (LA) Landfill Allowance Schemes. Disposal taxes however differ across the EU and can result in unnecessary shipments of waste out of the UK in an effort to avoid landfill taxes. Without suitable domestic markets for waste however, it is difficult to prevent. Scotland now has ambitious goals for reducing waste to landfill in Scotland with the ZWP putting forward a number of objectives, including landfill bans of specific materials, and a long term goal of no more than 5% of waste going to landfill by 2025<sup>1</sup>.

### 2.1 Waste quantities

According to Scottish Environment Protection Agency (SEPA) 16.88 million tonnes of waste were produced in Scotland in 2010 with the tonnage by source indicated in Table 1. SEPA provides estimates of approximately 8.81 m tonnes of material recycled and 5.52 m tonnes landfilled in 2010 (Table 1).<sup>2</sup>

Table 1: Estimated quantities of waste going to landfill in Scotland in 2010. *\*as estimated by waste return data;*

Source	Waste Production in Scotland (2010)	Estimated Tonnes sent to landfill	Estimated Tonnes recycled
	Millions of tonnes		
Household	2.77	1.61	0.71
C&D	7.47	1.23	4.70
C&I	6.64	2.68*	3.40
<b>Total</b>	<b>16.88</b>	<b>5.52</b>	<b>8.81</b>

*\*as estimated by waste return data;*

### 2.2 Size and Growth in the Scottish and UK Waste Sector

Approximately 130 Scottish enterprises were active in recycling and materials recovery (RMR) in 2011 with 160 local units.<sup>3</sup> These figures take into account enterprises whose primary business activity relates to recycling, but not specifically firms whose primary activities relate to the collection and disposal of waste materials, whether for landfill, recycling or other end uses<sup>a</sup>. In Scotland growth in number of enterprises involved in

<sup>a</sup>UK SIC (2003) 3710 (Recycling of metal waste and scrap) and 3720 (Recycling of non-metal waste and scrap classification were used for 2005-2008 data and equivalent SIC (2007) 3831(Dismantling of wrecks) and 3832 (Recovery of sorted materials) was used for 2009-2011 data.

RMR was 4% between 2005 and 2011, whereas growth in number of local units was 10% over this period. Enterprise growth relates to establishment of new business, whereas growth in number of local units suggests existing enterprises are expanding for example by adding regional branches. In comparison to Scotland, the UK as a whole growth showed higher growth in both the number of enterprises (30%) and number of local units (27%) over this period.

Approximately 155 Scottish businesses were active in waste collection, disposal and treatment (WCDT) in 2011 with 370 local units<sup>3</sup>. Growth in WCDT enterprises was observed to be much higher as compared to RMR at the UK level and for Scotland<sup>b</sup>. In Scotland growth in number of enterprises involved in WCDT was 82% between 2005 and 2011, whereas growth in number of local units was 28% over this period. In comparison to Scotland, the UK as a whole growth showed higher growth in both the growth in number of enterprises (111%) and number of local units (75%) over this period.

Three observations can be made from this data. First, growth in the waste sector in Scotland is below growth in the UK as a whole. Second, growth in the number of enterprises is much greater in comparison to growth in number of local units in Scotland for WCDT based enterprises providing some indication that there are new enterprises being created rather than existing enterprises expanding. And third and possibly most significant, growth in WCDT is much higher than for RMR. This provides an indication that the drive towards Zero Waste may be leading to disproportionate growth in the waste sector and may be indicative of material being collected in Scotland, but being transported to areas outside Scotland for recycling, recovery or reprocessing.

The Scottish Government targets under the ZWP will require diversion of more than 3 million additional tonnes of waste from landfill in Scotland by 2025. Planned landfill bans on priority materials will assist in achieving tonnages required to expand the sector, particularly demand for collection services, however, where end markets are not suitably developed there is a risk that higher levels of incineration and energy from waste (EfW) will result, as demonstrated in some EU member states where landfill bans were introduced relatively early<sup>4</sup>. Bringing EfW online too soon could result in competition for resources that could be put to composting or recycling<sup>5</sup>. In Scotland landfill bans will be preceded by a requirement in 2014 to sort dry recyclate and some food waste in order to ensure the treatment infrastructure required for segregated materials is in place<sup>6</sup>. Innovation in the sector however is required to ensure that investment in collection and processing capacity does not simply produce high quality raw materials for export from Scotland. A preferred increase in exports would be from added value industries producing manufactured products from recyclate.

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<sup>b</sup> UK SIC (2003) 9002 (Collection and treatment of other waste) was used for 2005-2008 data and equivalent SIC (2007) 3811(Collection of non-hazardous waste), 3812(Collection of hazardous waste), 3821 (Treatment and disposal of non-hazardous waste) and 3822 (Treatment and disposal of hazardous waste) were used for 2009-2011 data.

### **3 ACE Eco-Partnerships analysis of factors influencing the development of the Resource Management Sector in Scotland**

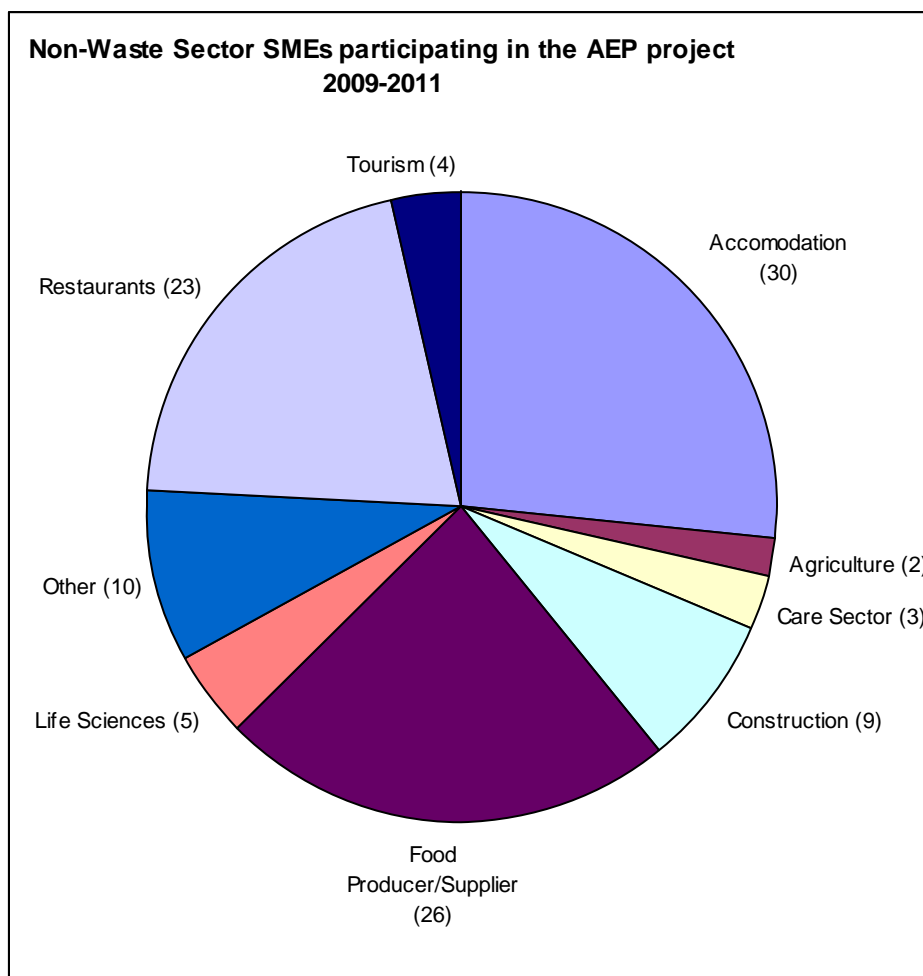
The ACE Eco-Partnerships (AEP) project carried out at University of Abertay Dundee between 2009 and 2011 worked with small and medium sized enterprises (SMEs) across Tayside, Scotland in both waste and non-waste sectors on improving resource efficiency and identifying opportunities for industrial symbiosis. The findings of the project highlighted a number of key barriers and opportunities to improve Resource Management (RM) in Scotland:

1. Factors influencing the quantity of recyclate available.
2. Factors influencing the development of processing facilities and end markets for recyclate.
3. Developing eco-innovation in SMEs and Third Sector businesses.

The AEP project also involved detailed work with a waste sector SME in developing new markets for recovered material. The work is highlighted as a case study of how eco-innovation in WM can lead to new business opportunities in resource recovery.

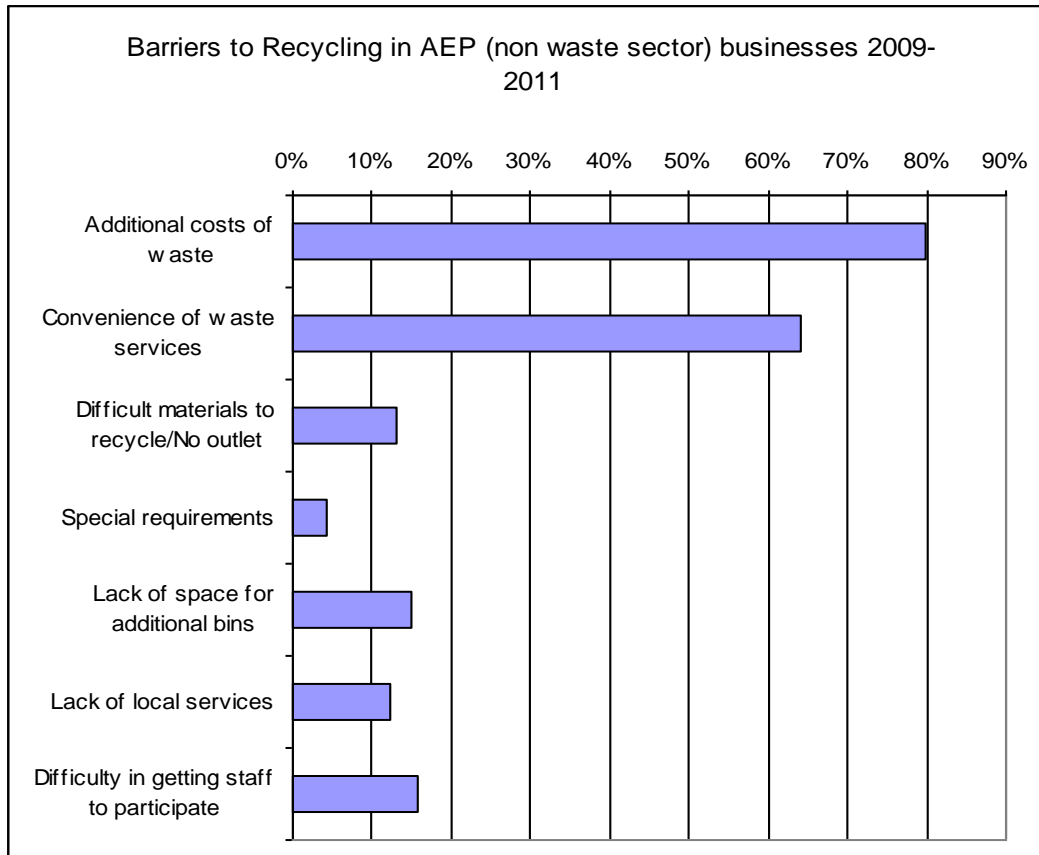
#### **3.1 Factors influencing the quantity of recyclate available.**

Waste management sector SMEs involved in the AEP project noted that access to high quality waste streams in sufficient quantities was important, particularly in reducing investment risk and improving access to funding. To date, efforts to increase recycling rates across the country have primarily been focussed on household wastes, where Local Authorities (LAs) have been driven to meet Landfill Allowance Scheme limits and reduce costs associated with landfill charges. Less effort has been placed upon improving recycling rates in the private sector where initiatives to improve recycling and reduce waste are driven by voluntary schemes such as the Cortauld Commitment (C&I) and “Halving Waste to Landfill” (C&D) initiatives and company directed EMS requirements. Organisations such as WRAP have provided support and awareness-raising in the private sector, however large quantities of waste are still being put to landfill in these sectors. The AEP project considered common barriers to increasing supply of recyclate derived from the private sector. Surveys of over 100 non waste sector businesses (primarily SMEs) were carried out across a range of business types from life sciences to hospitality to construction. The distribution of businesses interviewed is shown in Figure 1.



**Figure 1. Distribution of non-waste sector businesses interviewed in the AEP project 2009-2011**

Across these sectors, the main barriers to recycling were cited as the additional costs of recycling (80%) and the lack of convenience and ease of use of services (64%). Other barriers noted by SMEs are shown in Figure 2. A lack of general awareness of recycling services available and reluctance to spend time seeking out new recycling contracts was observed to be a barrier for the smallest businesses in particular.



**Figure 2. Barriers to Recycling as indicated by participants in the AEP project 2009-2011**

In terms of motivations to increase recycling, 77% expressed a desire to recycle more and apart from potential cost savings, about 20% of the businesses interviewed mentioned improving environmental credentials for the purposes of public authority tendering, environmental management systems or green business scheme accreditation as a motivation. WRAP carried out a review of existing literature, survey results and workshop results over 2010-11 looking at UK SME barriers to recycling<sup>7</sup>. Many of the outcomes support findings in the AEP study, however as noted in the WRAP study, barriers can be sector and businesses size dependent as shown in a GHK survey where only 7% of businesses indicated that cost was a barrier to recycling. This survey however noted that over 40% of the micro-SME respondents did not pay for waste services therefore had no costs associated with recycling unlike larger SMEs.

### 3.1.1 Cost Barriers to recycling

In Scotland, there are generally few financial incentives available to encourage recycling. In the private sector it is difficult to demonstrate cost savings from recycling, particularly for SMEs and businesses producing low quantities of waste. Pay As You Throw (PAYT) or Pay by weight systems have seen some success in areas of the US and Europe. In the US, there are approximately 5000 PAYT communities, where waste reductions of 14-27% have been experienced<sup>8</sup>. Systems that charge for residual waste but provide

significant discounts or no charge for recycling can also be effective. In countries such as the Netherlands and Germany, PAYT systems are seen as improving fairness in the charging schemes for waste<sup>9</sup>. These systems reduce the overall quantity of general waste disposed but increase quantities and quality of recycle dramatically.

For SMEs participating in the AEP project, the majority looked to LAs as a first point of waste services provision, particularly small SMEs in urban areas. The majority stated that costs were based on a fixed number of uplifts per week/month and fees were fixed regardless of whether bins were full or not. This was a particular disincentive for some businesses to procure additional bins to segregate waste for recycling. One business indicated that although they had been using a separate cardboard and glass recycling bin, they had reverted back to a single large general waste bin, as this provided them with a cost saving of nearly £2000 per year. Both SMEs and larger companies were interested in cost savings through improved waste management, and were willing to recycle more if it was cost effective but the majority did not realistically see that any cost savings could be achieved from recycling under existing service provision options. Within the WM industry, financial incentives to segregate waste were observed to be minimal, with skip charges being largely fixed, based on skip hire and transport, with little obvious linkage between the types of materials disposed of and charging. The firms that had attempted to procure segregated waste skips cited the cost saving to be on the scale of £5 to £10 per skip, and hardly worth the extra labour costs for training staff and sorting materials. The WM firms indicated that general waste skip contents for C&D waste would be recycled to levels up to 70%. It appeared that it was in the interest of the WM firm to carry out materials separation as an added value activity hence the pricing structure for segregated skips discouraged businesses doing this activity themselves.

### 3.1.2 Convenience and Ease of Use barriers

SMEs participating in the AEP project commented that the only way to get full employee participation in recycling was to integrate it into existing practices and methods of working, with minimal training or extra work required. Wimalaseena et al (2010)<sup>10</sup> studied the economic viability of recycling in the construction sector. A key recommendation to improve cost effectiveness of recycling was to introduce sorting systems that did not result in double handling of materials. Improving ease of use reduces the time required to manage materials, and maximises capture of recycle. This may highlight an area of innovation need amongst WM firms to provide effective solutions to business to improve the quantity and quality of materials that can be recovered. The businesses showing the best return for segregating and increasing recycle appeared to be those that dealt directly with waste re-processors or recycling firms that had a direct use for the material as opposed to “middle-men” collectors. This however did result in more time being spent seeking out end-markets for single waste streams and was only possible for businesses generating sufficient quantities to make it worth their while.

An area that was observed to show potential for increasing quantities of recycle being captured was improving collection logistics. For many SMEs, procuring recycling

services was only carried out when sufficient quantities were being generated. Across the AEP project, single waste stream investigations and interest in participating in local waste schemes was assessed. Many businesses expressed interest in participating in collective waste solutions for materials such as food waste or wood waste if coordinated on an industrial estate, or local scale. It was observed that although many of the businesses on their own did not produce enough waste to make single business contracts financially viable for WM firms, collectively small waste producers could provide sufficient tonnage for WM firms or recyclers to provide a service that was previously unavailable. However, determining who should co-ordinate this, or on what scale it should be rolled out or trialled was difficult to determine. Where the LA provided support for co-ordinating or highlighting opportunities to local businesses, there appeared to be greater support from businesses, as compared to WM firms initiating this activity themselves.

### 3.1.3 General awareness

Most businesses surveyed in the AEP project were engaged in some type of recycling and willing to recycle more; however, those that were not recycling or only minimally recycling clearly had a lack of awareness of available services and did not have a clear idea on the quantities of waste produced and the costs they were incurring. Many of the businesses cited a lack of clarity from waste service providers, including LAs on determining the most cost effective and sustainable waste solutions available. Many SMEs were unaware of the ability to recycle more than just cardboard, paper and glass through the LA. A lack of general awareness around market service level and pricing was observed, manifest by inconsistency in the costs of recycling services provided by both the public and private sector. Some businesses had recyclate collected for a reduced rate compared to general waste, whereas others were being charged the same as general waste collection or more, if additional bins were required. There were some notable differences for materials such as waste cooking oil where some businesses were paying for collection compared to others who did not pay or were being paid a fee for their waste oil by collectors. Waste cooking oil appeared to be one of the more competitive areas for waste uplift, with collectors travelling from as far as Liverpool to collect waste oil from Tayside and Fife. The AEP project, however, still found examples of waste oil being placed in the general waste bin of some businesses that were unaware of recycling services available to them. A similar situation was observed for waste metals and waste wood and surprisingly cardboard with some businesses paying for uplift, and others receiving free uplift or a fee paid for their materials.

In the C&D sector, the businesses with the lowest level of awareness about waste and recycling received the lowest level of benefit from recycling. Redmond et al (2008)<sup>11</sup> looked at studies of WM for SMEs in both the UK and Australia. The findings highlighted similar issues as those faced by ACE Eco-Partnerships SMEs, such as varying levels of awareness as to what a business should be charged for waste uplift. A lack of general awareness amongst many businesses prevents specific market expectations in terms of price and service levels from WM firms from developing.



### **3.2 Factors influencing the development of processing facilities and end markets for recycle.**

Increasing tonnage of available recycle in Scotland will require equivalent development of suitable end markets if high quality material resources are to be kept in Scotland. The ICE State of the Nation report (ICE 2011) highlights that quality of single waste stream is the most important factor in reuse however end markets for recovered materials must provide a sustainable demand<sup>12</sup>. In the AEP project, demand for products with recycled content in the private sector were largely based on either meeting public tender requirements or to demonstrate continual improvement or environmentally friendly practices under EMS or green business scheme requirements. Knoeri et al (2011) looked at decisions on using recycled content materials in the construction sector. Although successful examples on their use exist, uptake is still limited with decisions to use a recycled content material was based on recommendations of engineers or colleagues. Civil engineering projects were more likely to use recycled mineral construction materials compared to structural engineering where materials were still seen to be novel or niche<sup>13</sup>. Duran et al (2006) found that decisions to use materials such as recycled aggregate were linked primarily to the cost of virgin quarried materials – if virgin materials were more expensive, the choice of material would shift to recycled aggregate<sup>14</sup>. The location of the materials was also important with locally available recycle preferred over virgin material sourced from some distance. The effect of location of source is proportionate to the raw material cost, with low cost materials having higher proportional cost effects per tonne for transport.

Increasing demand for recycled materials can be related to awareness of the types and sources of materials with recycled content available. Both public and private sector stakeholders requested assistance from the AEP project on sourcing recycled content products. Public procurement channels may be central in stimulating demand for recycled content products and contributing to proving level of quality of products such as building materials or street-ware such as bins, bollards and outdoor furniture. However, to date, the source of recycled content materials may not be indicated or obvious. The visibility of “locally sourced” recycled content products is generally minimal apart from specific materials such as compost. With the drive towards more local sourcing of products, this could be an area of innovation by manufacturers in increasing the visibility of not just level of recycled content, but also source of recycled content.

The AEP project involved a small number of SMEs interested in developing end markets for waste streams in Scotland, either through energy and compost production, reprocessing and reuse or creation of value added products from recycled materials in new markets. A number of factors influenced development of end-markets. Access to high quality recovered materials in sufficient quantities was observed to be important, particularly in reducing investment risk and improve access to funding. Data on sources of feedstock was also important, however difficult to secure. Products that were able to be certified to waste Quality Protocols were provided with a marketing advantage.

Location of facilities and economies of scale were additional factors observed to influence development of end markets.

### 3.2.1 Quality:

Developing markets for recycle depends on a number of factors specific to each waste stream however will benefit from an increase in quality of recycle and demand for products with domestic recycled content. For waste processors, an essential factor in reducing costs and finding end markets for waste materials is to have clean, uncontaminated waste streams. Under the AEP Project, quality of feedstock was an important consideration for SMEs or third sector organisations investigating recycling opportunities. The quality of the feedstock had direct implications on the potential end markets for, and value of, their materials. The quality of feedstock was also seen to be vital to gaining quality protocol certification as poor quality waste streams could result in contamination of single waste stream recycle, not to mention additional handling costs.

Perceptions over the quality of materials derived from recycling as compared to virgin materials can still be a barrier to more extensive use of recycled content materials, even with established Quality Protocols (QP) in place. In comparing the use of virgin materials to recycle, an issue for end users relates to level of contamination within the reprocessed recycle. This is the case for almost all materials that will be used for manufacture into new products, and will be linked to end uses. Some materials will show limited potential for reprocessing into materials that will come in contact with food. For materials such as steel scrap, one of the biggest challenges is the identification and sorting of metals, particularly where mixed metals are present<sup>15</sup>. QPs are intended to provide end markets with a level of assurance that a recycled content material meets specific standards of quality. Obtaining QP certification can put recycling firms at an advantage to those without accreditation as has been shown for AEP project participants.

In the UK, QPs currently exist for materials such as compost (PAS 100), AD digestate (PAS 110) and recycled plasterboard (PAS 109). Certification of materials improves the marketability of a recycled product compared to non-certified materials and allows the “waste” designation to be removed; however, having QP certification does not remove all barriers related to quality, whether real or perceived that exist in the market place. The QPs may not assess all areas of interest to end markets. New uses for recycle, may not have been predicted when establishing protocols, therefore new markets may be reluctant to accept these until proven safe. A central resource providing access to additional research carried out on recycled content products could be a valuable resource for potential end-users. This could include both WRAP studies, and scientific literature to provide additional confidence in the behaviour of materials end-users may seek to procure.

### 3.2.2 Access to Data on available Feedstock

Under the AEP project, one of the most frequently requested area of assistance for SMEs and third sector businesses interested in joining the recycling sector was determining

level of feedstock available and where it was located. Although data on municipal waste is becoming more robust, data on C&I and C&D waste is still relatively poor in Scotland with the reality of materials flows largely unavailable for many waste streams. The situation is improving with additional requirements for data reporting on waste coming into effect in Scotland. Available quantities of food waste have been of interest in recent years as a priority material for landfill diversion, and potential feedstock for anaerobic digestion. Domestic food waste collection trials have taken place across several Scottish LAs, improving data on potential food waste arising from households. Currently the AD portal<sup>c</sup> provides mapping of all AD plants currently in operation in the UK, with details on quantities and types of feedstock taken in. This provides new developers with information on where feedstock may already be tied into existing contracts, or where there is under/over provision of services. Access to mapped data on quantities of materials available and location of current processing facilities and end markets for specific materials could assist the private sector in planning investments, and the public sector in identifying areas of need. A Scotland-wide materials flow mapping exercise would provide essential information needed by planners, waste managers, and private sector businesses to invest in the most appropriate location and scale of infrastructure needed for specific waste streams. The Waste Data Strategy for Scotland aims to produce a mass balance for waste, identifying how waste is managed and moves through production, distribution, and consumption markets<sup>16</sup>. This information is urgently needed to prevent resource leakage out of Scotland and allow planning for new facilities in the most appropriate locations.

### 3.2.3 Location of Processing Facilities/Economies of Scale

Simplified and tied up logistics and distribution networks could simplify access to feedstock issues by reducing a major barrier to economic viability of recycling, primarily transport costs. Potential savings have been shown to be the main motivation for private contractors in the C&D sector to engage in recycling, with the economic viability for recycling largely influenced by transport costs to facilities<sup>17</sup>. The viability of recycling businesses participating in the AEP project depended on local access to good quality feedstock however without adequate quantities, transport costs were an important consideration for AEP project participants. Successful systems of shared logistics appear to minimize the impact of transport costs and allowed some recyclers to source materials from a wider geographical area due to partnership working with other companies with transport needs in opposite directions. Smaller bulking stations appeared to be a more satisfactory solution compared to immediate collection and delivery direct to re-processors. This allowed materials to be collected in sufficient quantities to be transported when economical to do so. Looking for new end markets for recycle and locating processing facilities in closer proximity to product manufacturers may also improve the logistics of material flows<sup>18</sup>.

In the Waste (Scotland) Regulations 2012, requirements to segregate waste will present challenges to businesses where a coordinated approach to awareness raising and

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<sup>c</sup> <http://www.biogas-info.co.uk/>

collection schemes are not developed. In Edinburgh, the Business Improvement District (BID - Essential Edinburgh) has indicated intention to work with a specific WM firm to provide a single waste and recycling service contract for businesses. This arrangement is possible primarily because the 600 levy payers within the BID will be required to participate in the initiative, paid through their BID rates. However, where coordinating groups do not exist, such an arrangement could be difficult. AEP participants have already indicated the difficulty in developing new segregated collection schemes, particularly in offering services to small volume customers. In order to ensure high quality segregated waste streams, providing separate bins is essential for materials such as food waste, which are difficult to segregate from other waste streams post collection. The development of innovative solutions, both on the part of producers of waste and WM firms will be required to address location specific issues in advance of segregation regulations being put into effect. Innovations will need to take account of ensuring quality of waste streams is maintained while keeping the service convenient and cost effective for all parties.

In addition, innovative ways of funding developments may be required. As shown in the development of renewable energy projects, Energy Services Company (ESCO) arrangements are providing an alternative to communities, schools or other small groupings that would otherwise not be able to finance projects on their own. ESCO arrangements are being employed in AD situations where the risks and benefits are spread across stakeholders such as LAs, energy companies, technology suppliers and other parties that individually can't take the risks alone<sup>19</sup>. A similar situation for the RM in the form of a Resource Management Services Company (RMSCO) could allow for more coordinated partnerships to ensure effective closed resource loops could be developed. Waste collectors could assume risks of transport and logistics, LAs could assume risks of access to adequate feedstock supply and recyclers or technology providers could assume risks associated with technology deployment and development and end product development.

#### **4 Developing eco-innovation in SMEs and Third Sector businesses.**

According to the Scottish Government, several billion pounds of investment will be required to develop the capacity to meet Zero Waste goals<sup>20</sup>. In Scotland, the 3 major WM companies and two large independents operating in the LA market are looking to invest and grow<sup>21</sup>. These firms will be seeking out access to long term processing or treatment contracts and access to tonnage in order to make investment in facilities profitable. This will exclude many SMEs and Third Sector businesses that will be unable to secure the scale of tonnages and contract assurances to make a business case for accessing finance. Sharp and Luckin (2006) analysed the community waste sector in the UK and identified the key challenges that are facing third sector businesses. Two of particular importance include: *1. Increasing competition with the public and private sector to deliver services* and *2. The requirements of the tendering process being beyond the resources of a third sector organization*<sup>22</sup>. Large project tenders, particularly for LAs, often require integrated services (recycling and residual waste collection) on a large

scale, for durations of up to 20-25 years. SME and third sector recycling businesses are often excluded from consideration on the basis they would not be able to deliver the range and scale of services required.

The advantage for SME and third sector businesses, however, is their ability and willingness to innovate and adapt to a changing and challenging economic climate. Sharp and Luckin identified two basic features of effective recycling services; *the ability to innovate in terms of new and existing waste streams, and the ability to communicate effectively with the public and stimulate co-operation and participation in waste services delivered*. These are two features that exist in many SME and third sector WM businesses but are not actively encouraged through the current public waste services procurement processes. There are, however, opportunities in the provision of private sector services, particularly where service provision gaps exist at the moment, or current services are not fit for purpose for some waste types.

Within the AEP Project, the SMEs and third sector businesses that have shown success in the recycling sector have demonstrated the ability to be proactive in seeking out new opportunities, obtaining QP accreditation for end products, engaging with existing support networks and funding streams, and finding gaps in current service provision and adapting systems to suit new waste streams. At the current stage in RM development in Scotland, the larger players in the industry are primarily focussed on securing high-quantity, high-value waste streams that will allow economies of scale needed for capital investment. However, this provides an opportunity for smaller organisations to develop systems of collection and processing for lower quantity or value materials where service provision is underdeveloped, or end markets are seeking additional feedstock. SMEs and third sector businesses in the RM sector may be well placed to collaborate with small manufacturers or end users of recyclate, engaging with R&D providers to develop mutually beneficial systems for collection, processing and use of recyclate in the manufacture of new products.

#### *CASE STUDY: Plasterboard recycler.*

*In Scotland a number of waste management firms offer uplift of waste plasterboard from the C&D sector. However, due to the lack of a plasterboard manufacturer in Scotland, the demand for recycled gypsum for reuse in plasterboard manufacture is limited in Scotland, with recovered plasterboard waste primarily being transported to England for reprocessing. A Scottish SME recognised a potential business opportunity in processing waste plasterboard back into gypsum. The opportunity however depended on finding end markets for reprocessed gypsum. The company developed a processing facility to recover gypsum, and worked with SEPA on developing a quality protocol (QP) for recycled gypsum. The outcome was development of the PAS 109 QP for waste plasterboard derived gypsum, with the SME being the first PAS 109 gypsum producer in Scotland. This allowed the company to market, and sell, the gypsum locally, with the primary markets being agriculture and horticulture. Although the QP provided assurance of physical and chemical properties adhering to specific standards, the QP did not address all areas of concern to end markets. The AEP project carried out a specific study to assess properties of recycled gypsum in relation to soil pH effects, not assessed under the development of PAS 109. The study revealed that PAS 109 material behaved in a similar manner to natural gypsum in relation to pH, providing end-users with additional confidence that the material would not produce unexpected outcomes. With the assistance of AEP and Interface Innovation Voucher funding, the company was also able to carry out additional testing of other novel uses of recycled gypsum. The company is also investigating novel processing and end uses for other waste materials, becoming an excellent example of an eco-innovator in the waste sector. The company has shown innovation in all areas of the waste sector from collection to recycling to end-use development, which provides added benefit of controlling all stages of the waste to product pathway. Controlling waste collection services and processing allows greater knowledge of quantities and control over quality. Developing new uses for recycled gypsum are also assisting in increasing demand as quantity of supply increases. Materials collected in Scotland are thereby being transformed and put to new uses in Scotland.*

## **5 Conclusions:**

Currently, growth in the RM sector in Scotland is lower than the UK average and shows some imbalance towards collection and disposal as opposed to resource recovery, recycling and reprocessing. Capacity building in the Scottish recycling sector will require more than just legislative and policy instruments driven by government to achieve Zero Waste goals. Businesses themselves may benefit by taking a more joined up approach to managing waste with the potential for businesses to work together more, for WM firms to be more flexible and adaptable to business needs, and for the value of waste to be recognized. The development of end markets that process recycle back into usable product will be central to reducing material resource leakage from Scotland.

As demonstrated by AEP project, there is a need for eco-innovation across the RM sector to improve access to waste services, and to stimulate end-market development.

Innovation is needed in developing cost structures that encourage rather than penalise recycling. Waste service providers that are able to innovate in order to address some of the convenience and ease of use barriers to recycling will be able to maximise resource recovery and quality by making it easier for businesses to segregate waste streams and easily integrate recycling into existing practices. Awareness raising and innovation in how businesses access waste services could be developed, such as more visibility and transparency in pricing and service availability.

Demand for recycled content material needs to be addressed, however consumers can only begin to demand locally sourced recycled content materials if labelling and visibility of these products is improved. There may be eco-innovation opportunities for existing manufacturers to consider whether locally sourced recyclate could be used in place of raw materials either in full or in part. An increased range and scope of Quality Protocols for recyclate to address end-market needs could improve acceptability of recycled content materials as would visibility and access to research and data on recyclate uses by potential markets.

Innovative methods of recording and mapping accurate waste data and fate of waste-streams will be essential in planning waste infrastructure and collection schemes. Access to data on feedstock and current capacity levels for collection and processing is needed to ensure waste processing facilities are developed where they are most needed and to allow the markets, including manufacturers to see where they could be sourcing raw materials. SMEs and third sector business will be important in tackling some of the difficult and smaller volume waste streams, creating niche markets that are not in direct competition with big organisations however new cooperative systems of waste management may be needed to spread the risk of investing in waste infrastructure and capacity building, such as RMSCO arrangements.

## References:

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<sup>1</sup> SEPA and ZWS. 2011. *The Waste Data Strategy for Scotland 2011*. [Online] Available at [http://www.sepa.org.uk/waste/waste\\_data.aspx](http://www.sepa.org.uk/waste/waste_data.aspx)

<sup>2</sup> SEPA. 2011. *Waste Data Digest 2011* Zero waste plan data updated to include 2010 data [Online]. Available at [http://www.sepa.org.uk/waste/waste\\_data/zero\\_waste\\_plan\\_data.aspx](http://www.sepa.org.uk/waste/waste_data/zero_waste_plan_data.aspx) [Accessed 14/05/12]

<sup>3</sup> Office of National Statistics. UK Business: Activity, Size and Location (2003 to 2010). [Online] Available at: <http://www.ons.gov.uk/ons> [Accessed 14/10/11]

And

Office of National Statistics. UK Business: Activity, Size and Location (2011). [Online] Available at: <http://www.ons.gov.uk/ons> [Accessed 04/05/12]

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- <sup>4</sup> Remade Scotland. 2008. *An Assessment of the Economic and Job Opportunities Arising in Scotland in Relation to the Growth in Solid Wastes Management*. [Online]. Available at <http://www.remade.org.uk/reports/market-info/material-flows/an-assessment-of-the-economic-and-job-opportunities-arising-in-scotland-in-relation-to-the-growth-in-solid-wastes-management.aspx> [Accessed 14/10/11].
- <sup>5</sup> SQW. 2010. *Meeting Scotland's Zero Waste Targets. Assessing the Costs Associated with New Waste Management Infrastructure*. April 2010. [Online] Available at: <http://www.scotland.gov.uk/Publications/2010/05/24145920/11> [Accessed 19/9/11]
- <sup>6</sup> Waste (Scotland) Regulations 2012
- <sup>7</sup> WRAP. 2011. *Increasing SME Recycling*. Eunomia Research & Consulting March 2011.
- <sup>8</sup> Kolikkathara, Naushad, Huan Feng and Eric Stern. 2009. A purview of waste management evolution: Special emphasis on USA. *Waste Management*. 29, pp. 974-985.
- <sup>9</sup> Reichenbach, Jan. 2008. Status and prospects of pay-as-you-throw in Europe - A review of pilot research and implementation studies. *Waste Management*. 28, pp. 2809-2814.
- <sup>10</sup> Wimallesena, B.A.D.S., H. L. S. P. Madanayake, I. P. T. R. Weerasinghe, J. Y. Ruwanpura and J. P. A. Hettiaratchi. 2010. Recycling as a construction waste management technique. *Waste and Resource Management*. 163 Issue 2, pp. 49-58
- <sup>11</sup> Redmond, Janice, Elizabeth Walker, Calvin Wang. 2008. Issues for small businesses with waste management. *Journal of Environmental Management*. 88, pp. 275-285.
- <sup>12</sup> Institution of Civil Engineers (ICE). *State of the Nation. Waste and Resource Management*. Jan 2011 London.
- <sup>13</sup> Knoeri, Christof, Claudia R. Binder and Hans-Joerg Althaus. 2011. Decision on recycling: Construction stakeholders' decisions regarding recycled mineral construction materials. *Resources, Conservation and Recycling*. 55, pp. 1039-1050
- <sup>14</sup> Duran, Xavier, Helena Lenihan and Bernadette O'Regan. 2006. A model for assessing the economic viability of construction and demolition waste recycling - the case of Ireland. *Resources, Conservation and Recycling*. 46, pp. 302-320.
- <sup>15</sup> Yellishetty, Mohan, Gavin M. Mudd, P.G. Ranjith, A Tharumarajah. 2011. Environmental life-cycle comparisons of steel production and recycling: sustainability issues, problems and prospects. *Environmental Science and Policy*. 14, pp. 650-663.
- <sup>16</sup> SEPA and ZWS. 2011. *The Waste Data Strategy for Scotland 2011*. [Online] Available at [http://www.sepa.org.uk/waste/waste\\_data.aspx](http://www.sepa.org.uk/waste/waste_data.aspx)



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<sup>17</sup> See Wimalaesena et al, 2010 and Duran et al, 2006 above

<sup>18</sup> Remade Scotland (2008) An Assessment of the Economic and Job Opportunities Arising in Scotland in Relation to the Growth in Solid Wastes Management.

<sup>19</sup> Zglobisz, Natalia, Arturo Castillo-Castillo, Sue Grimes, Peter Jones. 2010. Influence of UK energy policy on the deployment of anaerobic digestion. *Energy Policy*. 38, pp. 5988-5999

<sup>20</sup> SQW. 2010. *Meeting Scotland's Zero Waste Targets. Assessing the Costs Associated with New Waste Management Infrastructure*. April 2010. [Online] Accessed 19/9/11 Available at: <http://www.scotland.gov.uk/Publications/2010/05/24145920/11>

<sup>21</sup> Remade Scotland (2008) An Assessment of the Economic and Job Opportunities Arising in Scotland in Relation to the Growth in Solid Wastes Management.

<sup>22</sup> Sharp, Liz and David Luckin. 2006. The community waste sector and waste services in the UK: Current state and future prospects. *Resources, Conservation and Recycling*. 47, pp.277-294.

## **Eco-innovation in SMEs – drivers of a holistic process of change**

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Track 4b: Markets, Institutions and Frameworks for Eco-innovation

Oral presentation

### **Extended Abstract**

#### **Purpose**

The paper aims to explore SMEs' understanding of sustainability issues, how they adopt and innovate in terms of sustainability and sustainable strategy, and the benefits and obstacles they face in developing, adopting and commercialising new products and processes. The concept of 'eco-innovation' or developing 'new products and processes which provide customer and business value but significantly decrease environmental impacts' (James 1997) is therefore applied to the specialised context of UK SMEs, a context which impacts cumulatively on overall environmental sustainability (Tilley 1999). Despite this, the implications for SMEs of adopting eco-innovation is under-explored, a gap addressed by this paper. "Eco-innovation is one step beyond Ecodesign and aims to develop new products and services that are not based on redesign or incremental changes to the existing product but rather on providing the consumer with the function that they require in the most Ecoefficient way" (Jones and Harrison, 2000). The concept of eco-innovation is researched in the context of SME capabilities and competences, and how these relate to the change process that emerges as a reaction to the drivers towards eco-innovation.

#### **Approach**

The research adopts an exploratory approach based on the case of a European Regional Development Funded knowledge transfer project, based at a UK university, which facilitates short interventions in sustainable product and process design. The experiences of 10 SMEs represent 'embedded cases' (Yin 2009) within the project, covering a range of industries from alternative energy generation to fashion knitwear and take-away food, chosen to provide consistency and

contrast, using a process of replication logic (Melnyk et al, 2001, Yin 2009). Each embedded case is based on interviews with company participants and collaborating academics, supplemented by documentary and observational evidence. While limitations of potential bias are noted since the research has been carried out by members of the project team, this is considered as a trade-off against the opportunity to gather longitudinal case evidence from a known 'hard to reach' population (Cassells and Lewis 2011). The research has therefore been undertaken before during and after the short interventions, and will continue in order to evaluate longer term impacts.

The case companies comprise 7 micro-enterprises, 2 small firms and one of medium size, representing mostly manufacturing business, and three with a service offer. Of the micro-enterprises, 4 have been established specifically to pursue their green product objectives. Of the remaining SMEs, 3 have adopted a strategy of diversification, 2 of product enhancement and the last one a strategy of cost reduction.

## **Findings**

The results build on the work of Tilley, (1999), Chakraborty (2010), Sharma et al 2010) and Cassells and Lewis (2011) which collectively emphasise the importance of a holistic approach to adopting eco-innovation, encompassing internal and external marketing and supply chain management to achieve a position of competitive advantage within which sustainability is embedded. In the cases, market opportunity, in contrast to compliance issues, cost or environmental benefit, is identified as a key catalyst for change in SMEs. Exceptions to this include the theatre, which has found it necessary to respond to stakeholder pressure to reduce running costs on the one hand, within the limitations of their listed building on the other: "We needed to find passive approaches to energy management to reduce our carbon emissions and energy bills". A contrasting exception is the Community Interest Company which established its web portal to provide businesses, designers and individuals with the knowledge and inspiration to re-use and recycle unwanted materials, in response to the eco-sensibilities of the founding social-entrepreneurs. Within days of its launch the portal received 6000 hits.

For those companies that exhibit market opportunity as their key driver, it is often apparent that other considerations need to be taken into account. One of the new start SMEs discovered in developing a new fast food concept that there were specific issues in some of the natural ingredients, not only in transporting them from the Caribbean, but also in food quality once they arrived. With support from a range of experts, both issues have been resolved. The entrepreneur stated "I had a wonderful wealth of inside information" and benefitted from support in concept development, marketing and branding his product, as well as the technical aspects mentioned. Another of the SMEs, who had developed a new product based on locally available materials, natural dyes and 'legacy' knitting designs found that upstream costs increased. Further product modifications have been made to reduce production costs, but the added value inherent in the product is beginning to be apparent in the market, and is proving popular for export.

Whatever the driver, the eco-innovating SMEs demonstrate a burgeoning inner confidence, which leads to the adoption of wider sustainable values and attempts to influence upstream practices in a number of ways: materials and energy use, recyclability (Sharma et al, 2010), localisation, and product to service shift (Maxwell and Vorst 2003) are all evident in the above mentioned cases. Interestingly, it is the new start businesses which come closest to embracing Tilley's strategic

ecology (1999), as these firms lack the legacy of traditional manufacturing firms, but are also generally instigated by eco-literate entrepreneurs. The extent to which any of the SMEs can reach true value-seeking success (Chakraborty 2010) or achieve measurable economic advantage is yet to be proven. Obstacles include the ephemerality of benefits (Shearlock et al, 2000), and practicalities of espousing eco-innovations internally and within the supply chain (Pujari 2006).

These obstacles could perhaps partially explain one further finding that emerged during the research. Each of the new start SMEs explained how they had taken several years to put their ideas into practice. The natural furniture maker suggested: “We planted the test plot in 2006, and have been experimenting with the shapes, structures and moulds since” and the alternative energy designer admitted: “I had the idea about 6 years ago, but it’s only now that the resources and knowledge have come together to be able to develop it.” These experiences confirm the need to amass a breadth of capabilities in order to pursue eco-innovation, but also that there may be a critical point at which confidence and eco-innovation capacity is realised.

### **Implications**

Contra to Tilley’s (1999b) assertion that SMEs are constrained in balancing economic and environmental performance, for some SMEs environmental change is seen as a vehicle to economic performance. For Beveridge and Guy (2005) the success factors of such ‘eco-preneurs’ are a messy combination of resources, personality and timing. The results here reveal the scope and challenges for SMEs to adopt more sustainable practices, encompassing innovations embedded within a broader but more systematic set of capabilities, that can be built over time. There are multiple points at which SMEs need to achieve sustainable advantage, with sustainability ranking against cost saving and market differentiation, and firms are required to accumulate capability in all areas to some extent. Indeed, Dangelico and Pujari (2010) find even experienced eco-innovators challenged by the trade-offs between the function, cost, quality and aesthetics of their green products when measured against those of conventional products. In contrast, the SMEs in this study are consistent with findings of Smith (2001), mostly embedded in niche markets, and consequently their eco-impact is limited. Nevertheless the SME participants are keen to enhance their awareness and circumvent the process of gaining ecoliteracy – a consideration for future policy and business support. Furthermore, while SMEs need to embrace all aspects of eco-innovation, those with initial drivers focused on market opportunity and a lesser extent stakeholders are most constrained in their approach to eco-innovation, seeking markets for relatively similar products or services. Those with innovation as their initial driver lacked the constraints of preconceived market expectations and cost limitations, though for all three SMEs this has become a more sensitive issue further into the process.

### **Value**

The paper informs the emerging debate on sustainability in SMEs, providing a rich source of data to enhance the provision of business support and knowledge transfer activities. For SMEs to be true eco-innovators, their product and service innovations need to be matched by opportunities within the market, environmental impact and cost reduction, stakeholder engagement and an indication of the eco-advantages of the full package. Innovation and change management therefore need to form a single integrated process which for an SME could encompass the sequential gain of a set of competencies. Interventions may need to embody the different knowledge, skills and competencies

associated with each of the above elements into a single person, often the SME owner themselves, and this is reflected in the development of a model. Further research is needed to test the effectiveness of such a model and establish the longitudinal aspects of eco-innovation in the search for competitive advantage among SMEs.

**18th Annual International Sustainable Development Research Conference**

**University of Hull, 24-26 June 2012**

## **The potential for the production of sustainable absorbers from waste material**

**Track 4c: Resource strategies: Industrial ecology, waste management, material cycles, and life cycle analysis**

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Oral Presentation.

Abstract.

Contamination and pollution of soils and water is a global problem which is reducing the land available for food production. Additionally contamination may pose an environmental hazard, being directly detrimental to human, and the wider ecosystem's overall, health and resilience.

A major source of metal contamination is the aquatic flux produced from abandoned mine sites and the processed associated with mining and processing metal ores. This contamination causes both chronic and acute damage to groundwater and water courses, from highly localized effects to impacting upon entire river basins at a nation geographical scale.

Adsorption of contaminants onto an adsorbent is a widely accepted method of treating contaminated water. The development of an adsorbent from available waste streams which is both effective and sustainable is a challenge for the removal and recovery of metal contaminants.

An effective and long-standing method of reducing the risk of pollution transfer has been found to be the adsorption of contaminants to an adsorbent. Carbonaceous materials have been shown to strongly sorb both organic and inorganic pollutants. A potential source of materials is waste; there are a wide range of waste streams available which could act as potential sources of materials for the production of an effective adsorbent for decontamination purposes. Some non-carbon materials also have the properties required for adsorption, hydrous ferrous oxide (HFO) is such a material and has the potential for the removal of metals from contaminated groundwater. This is a waste stream which is produced as a result of mining activities and currently typically ends up in landfill.

This study is focusing upon spent coffee grounds and HFO as the potential source for the production of a sustainable and effective adsorbent for the removal of metals from contaminated wastewaters typically found at abandoned mine sites.

This study is investigating the pyrolysis of spent coffee grounds to produce a carbonaceous char for the production of an effective material for the removal of metals from contaminated mine waters. Char is not the only product from pyrolysis, in addition there is a liquid and gas fraction both of which can be used as fuel. The configuration of the pyrolysis process controls the proportions and properties of these 3 products, the feedstock used also strongly affects the characteristics of these products. This has significant implications for the overall sustainability of the production and deployment of this material for decontamination purposes in terms of its overall life cycle analysis. In addition to the pyrolysis of spent coffee grounds for purposes of char production, investigation into the effectiveness and sustainability of using HFO for the same purpose is also being investigated.

The key research questions and methods are:

How effective are, carbonised coffee grounds and hydrous ferrous oxide for the removal of metal contaminants from waste water? Experiments have been designed to assess the effectiveness for metal removal from contaminated wastewater by pyrolysed spent coffee grounds and HFO, from different mine sites. The effectiveness of these waste materials are being compared to commercially available materials including, ochre, and carbonised coconuts char. Characteristics of the spent coffee ground char and HFO are being assessed using BET analysis, SEM and DTA techniques.

How sustainable is the production and deployment of carbonised spent coffee grounds and HFO for the decontamination of wastewaters produced from the specific waste material? Life cycle analysis techniques and modelling will enable a quantitative assessment to be made of the environmental impacts of this method of production.

Is this an environmentally justifiable thing to do? Do the potential environmental benefits outweigh the environmental impact that this process has? In order to answer these questions an understanding of the broader context in which the sorbents is to be produced is required. An understanding of the modes of deployment and the requirements for up scaling these sorbents for

use on contaminated sites will be needed in order to assess the overall sustainability of this method of metal removal from contaminated wastewaters.

Is it possible to produce an effective and environmentally sustainable adsorber from waste materials?

Work so far suggests that there is the potential to create a useful adsorber from waste streams, which balances the environmental benefits and impacts of the method of production, against the benefits and impacts of deployment and disposal in terms of the overall life cycle. This research will provide information about the effectiveness of specific waste materials environmental remediation of wastewaters. It will also seek to highlight the wider environmental implications that need to be considered if an effective adsorber is identified.

This work could have implications for decisions about waste management strategies for various materials and the most effective and sustainable method for managing them. Additionally it presents the potential for development of useful materials from previously unutilised feedstocks which could reduce both the environmental burden of producing these materials and their cost.



**Living labs as a reflexive user-driven research infrastructure  
to promote sustainable consumption and production patterns:  
Experiences from exploratory research**

Paper for presentation at the 18th Annual International Sustainable Development Research Conference  
University of Hull, 24-26 June 2012, Track 4d: Sustainable Consumption and Lifestyles

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*"Work in progress. Please do not cite without author's permission"*

**Abstract**

Humankind faces serious environmental and developmental challenges in the twenty-first century, such as climate change, resource scarcity and conflicts, rising energy generation and supply costs, diminishing access to clean water, poverty and drastic loss of biodiversity. In this context, sustainable consumption is widely regarded as a particularly suitable approach for addressing these issues in an integrated and systemic way: It is argued that a progressive transformation of consumption and production patterns is needed in order to live within environmental limits and to serve intra- and intergenerational justice. Participatory product development, especially the user integration in early stages of open innovation processes, and the broad diffusion of eco-innovation in value chains play an important role in this regard.

Against this background, the paper discusses the concept of the Sustainable LivingLab (SLL) as a reflexive user-driven research infrastructure for the development of technological and social innovations that promote more sustainable patterns of consumption and production. By integrating users and other relevant actors in the user's context at an early stage of the innovation process, better chances for the successful diffusion of innovations with lower life-cycle impacts can be expected. In this way, a SLL infrastructure helps fostering the adoption of eco-innovations by users, e.g. by supporting consumers to take advantage of their full resource and energy savings potentials. At the same time it is important to recognize unintended side effects can be recognized at an early stage of the development process. For example, potential negative rebound effects - starting at the level of individual consumption and technology use, following a centrifugal dynamic to encompass wider spheres of life, such as the neighbourhood, community, and the wider economy - should ideally be identified early. In order to do so, a SLL requires a reflexive approach and should consider more meso-level oriented approaches of transition management and global ecological limits.

The paper discusses and reflects results from ongoing applied sustainability research at the Wuppertal Institute, including explorative studies on how to set up SLLs at unit level and at

the level of a research infrastructure as well as networks that coordinate corresponding research activities at the national and international level.

## **1. Introduction**

Transforming value chains by developing new products or services, that successfully respond to the increasingly dynamic and complex requirements in society, is a key challenge for economic actors. These requirements are reflected in trends such as demographic change, climate change, resource scarcity and depletion, or more individualised lifestyles. In the last decades a large number of potentially sustainable product and service innovations have been brought to market, without large-scale integration of users during innovation processes, e.g. new models of supply, car sharing, new lighting systems or “just” less energy-consuming water boilers. However, these developments often do not perform in the intended way because of unexpected user behaviour (Liedtke et al. 2012a).

New pathways to responsible consumption and production are sought to meet these urging challenges and requirements. Education for sustainable consumption and promoting consumer citizenship are relevant preconditions for a change of direction (Welfens et al. 2010a). Overall, new social structures and processes in business and economy are required to enable sustainable consumption. How can sustainable product or service innovations be developed that do not show negative rebound effects in everyday use and at the same time increase user comfort and, thus, acceptance? This question is of high importance for transforming value chains towards more sustainable patterns of consumption and production. The average lifestyle of people in industrialised countries is characterised by high levels of consumption and is, thus, responsible for an enormous increase of resource extraction and environmental problems (Jackson 2005). Due to its high demands for energy and materials, housing is now considered one of the most important areas for a transition in consumption and production patterns (Spangenberg and Lorek 2002; Druckman et al. 2011).

In this paper we introduce Sustainable LivingLabs as a research approach that explicitly addresses sustainable consumption and production. The paper is subdivided into the following sections. Section 2 discusses the conceptualisation of LivingLabs, while section 3 introduces five research lines, comprising a research agenda for LivingLabs. Following this, in section 4 we outline current research activities at national and international level, employing the extended Sustainable LivingLab approach. This extended research infrastructure focuses on sustainability assessment along the entire value chain at different stages of the innovation process, thus aiming to shift consumption and production patterns towards resource efficiency and sustainable lifestyles. The conditions for a German SLL are explored based on interim findings of an ongoing research project with a German focus. In the last chapter, we resume the potentials of Sustainable LivingLabs and draw conclusions with regard to pathways to more sustainable value chains.

## **2. Conceptualising Sustainable LivingLab<sup>1</sup>**

Sustainable LivingLabs are an infrastructure to put users and other value chain related actors on centre stage in the innovation process and design of sustainable products or services, thereby reducing negative rebound effects through studying user-technology interactions in real-life settings (see Druckman et al. 2011). This way of integrating users in LivingLabs can provide an innovative way towards a more responsible lifestyle by changing structures and processes of developing sustainable products and services in industrial research. The in-depth study of everyday practices in domestic contexts and the drawing on evaluative feedback to

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<sup>1</sup> This section is mainly based on Liedtke et al. (2012c).

prototypes in real-life enables new processes for sustainable consumption. Even though some potential for resource efficiency lies in the fields of individual decision-making, behaviour and competence development (Green and Vergragt 2002), it should not only be put on the shoulders of individual consumers (Welfens et al. 2010b). Much more, changes in structures and processes in economy are needed, i.e. to use the potentials of open innovation processes. To this end Sustainable LivingLabs can contribute to necessary changes in society (i.e. opening of enterprises, integrating and activating essential stakeholder groups, enabling learning processes) by taking the next step in user-centred design. The research approach thereby aims to foster interactive and cooperative value chains (Schelske 2008; Walther 2010).

The Sustainable LivingLab is defined as an infrastructure designed to enable open innovation processes, in which users and other actors, relevant for the context, actively participate in development, testing and marketing, respectively of new products, services and system solutions. The interactive innovation process is situated in real life surroundings (living space, work environment, mobility, urban space). It is led by sustainability criteria and aims to contribute to global and universally applicable patterns of production and consumption (see Liedtke et al. 2012c).

The Sustainable LivingLab approach integrates several aspects of different research strands like consumption research as well as innovation, sustainability and transition research and recent developments in these fields (like theories of social practices, user integration, action research and sustainability assessment with focus on the entire value chain).

**Sustainability science** has accumulated considerable knowledge on tools and methods for sustainability assessments (see e.g. de Ridder, 2005; Clark et al. 2004). Also for assessing value chains, a number of methods and tools have been developed for different scopes and levels of data collection (site, company, supply chain, product, consumption) (e.g. Baedeker et al. 2005; Klöpffer and Renner 2007; Schaltegger et al. 2007; Project Group on the integration of social criteria into Life Cycle Assessment 2008; Geibler et al. 2010). However, these often show limitations as some of them do not consider the entire life-cycle (Baedeker et al., 2005). In addition, indirect effects are often not considered for analysis at the value chain level due to the limited knowledge on causal links (Geibler et al. 2010). For example, the supply of increasing market demand for one product might have effects on other markets, e.g. through psychological rebound effects (Paech 2005). The LivingLab approach addresses this problem by aiming to integrate the user as the most relevant expert (and cause of rebound effects) in the innovation process. In our continued research, the LivingLab approach has been extended in Germany, focussing sustainability assessment at different stages of the innovation process and resource efficiency (compare Three-Phases Model of Research in section 4).

**Innovation** processes underlie a tendency to get more and more opened up, integrating stakeholders, other businesses and end-users in the process of developing new products or services, already at early stages of development. Concepts like “open innovation”, brought into discussion by Chesbrough (2003), “wisdom of crowds” (Surowiecki 2004) or the “lead-user”-concept (von Hippel 1986) as well as the design of transformational products (Hassenzahl et al. 2011, Laschke et al. 2011), have recently promoted research in co-creation and led to a number of new business models and management tools to integrate users into innovation processes. Open innovation here means to make use of the purposive in- and outflow of knowledge across a company’s borders to accelerate internal innovation (Chesbrough 2006). Results show that these concepts can significantly reduce the risk for innovations to fail on the market, especially for radical innovations under uncertain market or technological conditions (Clausen et al. 2011: 35). Different methods of interaction have been developed, e.g. non-/ lead-Users involvement in innovation workshops for sustainability

innovations around the home (Diehl 2011) or web 2.0 tools to use collective intelligence (Leimeister 2010). However, open innovation research has so far seldom paid enough attention to the potentials for sustainability innovations.

**Changing routines** towards more environmentally responsible consumption patterns requires consumers to develop a consciousness for the social and ecological consequences of consumption practices (Ahaus, Heidbrink, Schmidt, 2011). However, research on the role of consumption for more sustainability revealed a gap between consumers' apparent knowledge about, for example, high ecological impacts of certain products, and acting according to that knowledge in everyday routines (Heidbrink, Schmidt, Ahaus, 2011). This gap at the consumer side limits the possibilities of establishing more responsible consumption patterns; it even increases the risk of negative rebound effects, which can potentially overcompensate for particular benefits. LivingLabs focus on the diffusion and user acceptance of sustainability innovations by involving users and other relevant actors along value chains into design processes (Heidecker et al. 2010).

Taking up the idea of open innovation and user-oriented design, our approach additionally draws on results of research in **systemic innovation** and social studies of technological development. Integrating the thesis of "co-evolution" of innovation trajectories (Rip and Kemp 1998), it can be concluded that sustainability innovations, which are meant to be successful in the long-term, can only be developed in an experimental and interactive setting (co-design). To involve users into research processes, the approach can also draw on insights from the methodology of action research (Lewin et al. 1953). Action research assumes that scientific findings can only be achieved if professional researchers take up concrete social problems in reality and actively involve 'laymen' into their research, in order to try and intervene in existing social structures. The LivingLab approach can be adapted flexibly according to a defined research design. Thus, users and stakeholders can be involved at all or at specific stages of research, i.e. in the phases of *defining a problem*, *designing a research strategy*, *creating results* or *application of results* (Talwar et al. 2011). The LivingLab infrastructure provides means to observe practices involving technical artefacts in the process of everyday use. The potentials of new prototypes to change current practices and, thereby, potentially change rules and resources of systems of provision bottom-up, can be analysed in real-life settings. Social practices in using the new product have to be regarded during the innovation process, since all too often products designed for environmental efficiency under given circumstances are misused or overused, resulting in unintended and generally less sustainable outcomes ('the rebound effect') (Liedtke et al. 2012b).

**Transition research** studies complex socio-technical change processes to meet challenges of sustainable development, aiming to identify underlying patterns and dynamics (Geels and Schot 2007). A multilevel perspective on change as an interplay of developments on the three functional levels 'landscape', 'regime' and 'niche' is in the centre. Transition means a deep change of 'regime' of a specific system. 'Regime' here refers to the currently predominant structure of a social system in terms of culture, dominant values and patterns of action. A process of change in material infrastructures, organisational structures, values and norms to establish new patterns of perception and action (transition) can be induced by combining several different developments (Kemp and Loorbach 2006). To describe such complex processes of change the Circular Transition Model was developed, which distinguishes the phases of Problem Assessment, Vision Development, Experiments and Learning & Upscaling (Loorbach 2010). At the Wuppertal Institute transition research is established as a meta-approach for the institute's research and development in sustainability (Schneidewind et al. 2011). The phases of Experiments and Learning & Upscaling can especially well be conducted within the Sustainable LivingLab infrastructure. The methods employed in the

research infrastructure, as we will describe in the following section, can serve as an example for these parts of the circular model.

### **3. Five Research Lines for a LivingLab research agenda<sup>2</sup>**

Focussing on sustainable homes and related value chains, Product-Service-Systems or Sustainable Consumption-Production-Systems, Sustainable LivingLabs can help to identify new ways in one of the most crucial areas for reducing resource extraction and environmental impact (Rohn et al. 2011). Actually, modern sustainable homes are often rather high-tech environments. Home occupants have to monitor, manage, maintain and live with complex technology interfaces, connecting and interacting with heating, cooling, ventilation, lighting, communication, and energy management systems of the home. Thus, it is one of the key challenges to find out to what extent people can indeed successfully interact with this potentially complex range of systems. Furthermore, it is to be explored in how far this interaction leads to more sustainable households over time along five generic research lines (Welfens et al. 2010b).

Initially, the LivingLab infrastructure including the methodology and research lines was developed and implemented in a design study within the 7th Framework Programme of the European Union (2008-2010), conducted in a cooperative project by four academic (led by TU Delft in cooperation with ETH Zurich, Universidad Politecnica de Madrid, Wuppertal Institute) and three industrial partners (ACCIONA, BASF, Procter & Gamble). It aimed at understanding why sustainable technologies that seem technologically and behaviourally adequate, and despite people's willingness to act for sustainability, often do not perform in the intended way in real life. The research infrastructure concentrated on human-technology interactions, acceptance and adoption of sustainability innovations focused around the home, such as ventilation, water and energy management. Its basic assumption was that, in order to research user acceptance and rebound effects, human-technology interaction must be understood within the context of everyday practices of utilisation (Bakker et al. 2010).

Within the Design Study five research lines were defined based on a foresight process analysing and evaluating global megatrends. An expert panel of the LivingLab consortium ranked these megatrends in order of their relevance for sustainability and the LivingLab approach. The trends were chosen in terms of how they affect innovation intensity, competitiveness and user orientation. Employing a cross-impact analysis of the most relevant megatrends and basic functions of homes, important research questions and topics were elaborated. These again were summarized to five research lines, helping to structure the potentially broad scope of the LivingLab infrastructure. These five generic research lines are (Welfens et al. 2010b; Liedtke et al. 2012b):

#### *Design, construction and maintenance of sustainable homes*

LivingLab facilities are highly visible examples at the frontier of sustainable building systems for reducing emissions, material consumption, energy and water use. This research line is thus close to the primary idea of LivingLab, founded at the MIT, and focuses the collaborative development and testing of i.e. easy to install and user-friendly systems or materials that can easily be dismantled, separated or reused. Another focus is on implementing feedback loops between actors and decision makers in planning and construction.

#### *Integrated approaches to home energy management*

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<sup>2</sup> This section is mainly based on Liedtke et al. (2012c).

Sustainable LivingLab offers a unique opportunity to study the integration of demand-based energy offerings and related services in combination with smart appliances and low-energy heating and lighting solutions. For the purpose of this paper, this research line serves as a case study (compare below). The focus here is on developing interaction designs and smart systems (smart meters, smart grids) that can encourage and support inhabitants in saving resources, whereas complex control technologies become an integral part of such systems. Therefore, the Sustainable LivingLab infrastructure can provide an opportunity to study user-technology interactions. Working prototypes should be placed in a real-world context, involving actual consumers. Research questions mainly consider:

1. The physical design of the product, including perceived physical affordances, ease of use, and pleasure in use.
2. Social interaction issues, including perceived social norms, i.e. how much energy does a comparable household in a similarly sized house consume?
3. The perceived environment as recognized by the energy savings system, including issues like the amount of daylight, outdoor temperature, or detected user activities.
4. Financial and environmental incentives for indicating at what time of the day there is a grid surplus of green energy.

#### *The connected home*

Rising virtual services such as tele-working, tele-shopping or social connectedness in the web 2.0 have a potential to radically change habits, develop new markets and increase resource efficiency at the same time. This indicates the need to extend the scope of LivingLab research questions also on activities beyond the home, since implications of this on-going virtualisation of working, social interaction and consumption should be considered.

#### *Resource-efficient lifestyles and social networks*

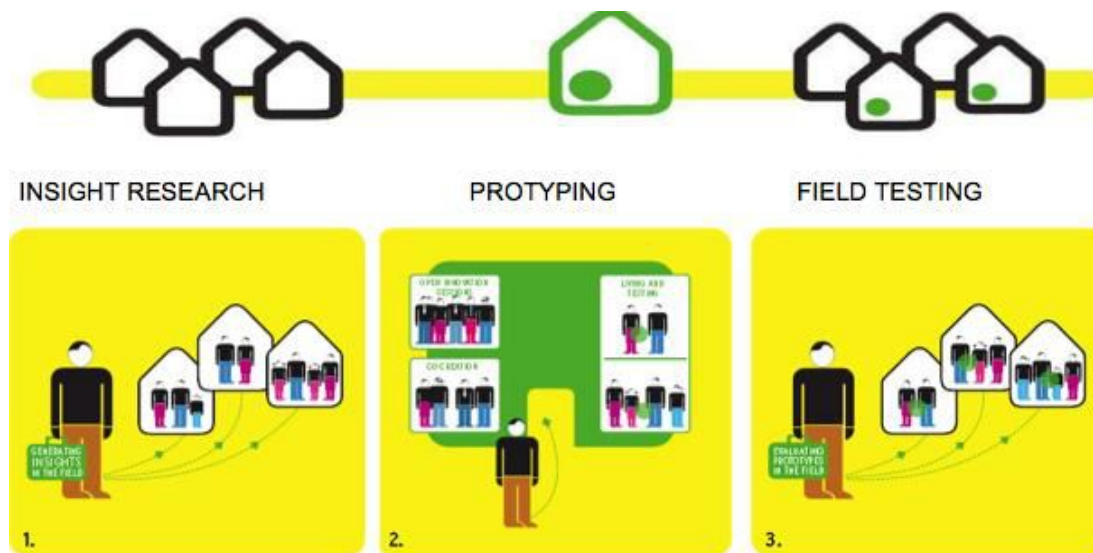
In connection to the last research line, the Sustainable LivingLab approach offers the possibility to study lifestyles and consumption patterns in a real-world setting. The role of user's motivations and pleasure in interdependence with socially constituted ways of using a certain product or service, forming social practices of consumption, can be studied. Even within relatively homogeneous groups of users (in terms of age, education and socio-economic situation), studies have shown that varying consumption patterns can lead to vast differences in the amount of energy and resources used by households (e.g. Kotakorpi et al. 2008). Furthermore, the impact of training sessions for end consumers and awareness tools (such as smart meters) can be analysed. Do users change their actions in result, does this achieve energy savings, and how can tools be improved, i.e. in terms of visualisation with colours, graphs or figures?

#### *New product and service development*

“Products with significant environmental effects in the use phase should be developed in LivingLab with a clear focus on the user context to prevent unwanted side effects” (Liedtke et al. 2012b: 12). Trends, such as the increasing percentage of electronic devices at home or the growing trend to work at home offer a seemingly endless range of possibilities to create new sustainable practices around them, especially at this early stage.

### **4. Developing a Research Infrastructure and Methodology for Sustainable LivingLabs**

In the initial Design Study, a three-phases model of research was developed under the lead of TU Delft, which served as a conceptual framework of methods to conduct innovation processes in LivingLabs (see Figure 1).



**Figure 1: Three-Tier Model of Research in the LivingLab Design Study (Bakker et al. 2010: 11)**

In the first tier “Insight Research”, human needs were to be analysed within their everyday context, i.e. their own homes, while in the second tier “Prototyping” new products or services were tested within the LivingLab dwellings. On this basis, prototypes were (re)designed and then tested in the field in the third tier (Bakker et al. 2010).

In relation to the management of interactive value-added processes (Schelske 2008; Reichwald and Piller 2006; Walther 2010) the Research Group 4 “Sustainable Production and Consumption” at the Wuppertal Institute extended this methodology for user-integrated design of products or services. The objective is to early identify trends in the field of Sustainable Consumption and Production and integrate all relevant actors in value chains (producers, handicraft, consumers, users, consultants etc.) directly into the development of research strategies and product design – thereby, focussing on resource efficiency and sustainable lifestyles as well as basic innovations with an increased demand for change. Besides developing resource-efficient technologies and product-service systems (Rohn et al. 2011), main emphasis is put on contributing to a culture of more resource efficiency in economy and lifestyles (Low Resource and Carbon Society). Furthermore, requirements for change in value chains and their management are to be derived.

The research objectives followed are to analyse relationships between home occupants’ behaviour, domestic resource consumption and domestic systems (products, technologies or infrastructures, i.e. mobility), with the aim of minimising resource consumption and waste production, while still optimising users’ experience and comfort. Participating households test the obtained solutions, before the other value chain related actors are involved in stakeholder dialogues on new prototypes.

Currently, the Wuppertal Institute is cooperating in two research projects at national and international level, which build on the initial Design Study and further develop the LivingLab idea for sustainability innovations with special focus on sustainable lifestyles and resource efficiency. Interim results are presented below.

### **Exploring potentials of a German infrastructure for Sustainable LivingLabs**

The Wuppertal Institute is currently conducting a research project in cooperation with Fraunhofer IAO, Fraunhofer ISI and Faktor 10 – Institute on “Sustainability Innovations in LivingLabs”, funded by the German Federal Ministry of Education and Research (2011-2012). This project focuses on Germany and a specific national infrastructure for Sustainable LivingLabs. Main research questions included are: In which fields can LivingLab be expected

to gain a high potential for sustainability innovations? What should a German research infrastructure look like in contrast to the European design study, if these potentials are to be engaged? What are suitable starting points for such an interactive setting in the existing German Research and Development landscape? What are fields of application (technologies, products, services) where Sustainable LivingLabs can offer a high potential for sustainability innovations. Also, a dialogue between relevant actors is part of the project.<sup>3</sup>

Within the project, the German research and development (R&D) landscape is screened. Thereby, suitable starting points for interactive and systematic research on product and service use in domestic and workplace environments and their sustainability implications are analysed. The aim is to create a profile of the corresponding status quo. Interim results of the project, highlight that the existing German research and development (R&D) landscape is scattered and heterogeneous with respect to a potential SLL infrastructure. On the one hand there are just a few institutionalised infrastructures in place, such as the Fraunhofer-inHaus-Center, set up by the Fraunhofer-Gesellschaft. Fraunhofer-inHaus combines the potential of seven Fraunhofer Institutes and around 100 partners from industry with the objective to develop, test and demonstrate new solutions for rooms and buildings, and bring them to market. On the other hand, there are various project-based living lab initiatives, such as the “Neighborhood Lab” of the Design Research Lab at the University of the Arts Berlin. In both types of LL sustainability and especially ecological aspects are not considered intensively. Consequently, there is a need to support and develop a research infrastructure for SLL.

With respect to the potential fields of application the results confirm the research lines identified in the European Design Study. Findings show a demand for different types of living labs, depending on the area of application: Living labs for homes, retail living lab as well as regional living labs. In each area of application, a number of products and services could be identified with resource efficiency. In order to develop a German research infrastructure, however, several challenges have to be met. A number of barriers could be identified within the project (table 1). The ongoing project will further refine these results and explore strategies how to overcome these barriers.

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<sup>3</sup> For more information on the project see:

[http://www.wupperinst.org/en/projects/proj/index.html?projekt\\_id=398&bid=139](http://www.wupperinst.org/en/projects/proj/index.html?projekt_id=398&bid=139)



**Table 1: Barriers for a German SLL Infrastructure (Geibler et al. 2012)**

<b>Barriers</b>	<b>Description</b>
Limited long-term funding	Project-based funding can make it difficult to pursue cross-cutting sustainability aspects over the medium to long run.
Bureaucracy in funding organisations	Funding organisations work according to the logic of good housekeeping – which might not always be appropriate for pursuing the logics of sustainability and innovation.
Lack of methods and standards	There is a lack of suitable methodological standards for the evaluation of sustainability. “Sustainability” can usually only be evaluated on the basis of aggregated data. On the micro-level of living labs alone it can be difficult to evaluate the aggregated sustainability effects of innovations (e.g. because of rebounds and networks effects). Existing methods of sustainability evaluations only cover partial aspects, e.g. resource efficiency.
Limited appreciation of acceptance research	Research into technology acceptance does not receive sufficient appreciation. Often producers are rather focused on technical functionality.
Short-term perspective of companies	The logic of companies and business development associations is too much driven by profitability in order to systematically integrate sustainability. The time horizon of companies is often too short for dealing comprehensively with sustainability problems. Companies may tend to integrate users only superficially in development processes when they already have preferred solutions “in the drawer”. There is the danger that firms might not want to pay for independent research but rather expect advertisement for their own products.
Fear of transparency / privacy issues	Companies may shy away from transparency requirements, as they dislike the prospect of receiving bad publicity when their products or services are compared to those of competitors. Without sufficient incentive users may not be willing to accept infringements on their privacy. It can be challenging to motivate users for longer periods of time.
Divergent expectation of involved actors and competition	Companies and users have divergent temporal horizons: While users want improvements straight away, firms may only want to test their novel solutions at specific points in time. Furthermore, user-groups can be very heterogeneous and thus may not always be representative for the wider population. Competition among firms and research institutes alike can make cooperation difficult. Technological competition can be a hindrance to open innovations processes. As the innovation process is open, the optimal partners cannot be known at the beginning of a project, but involving new partners is often difficult.
Communication barriers:	Researchers, users and companies speak “different languages”. There is a lack of mediators between “soft” factors such as user-integration and scientists engaged with “hard” technologies. Mediation can also lead to information losses.

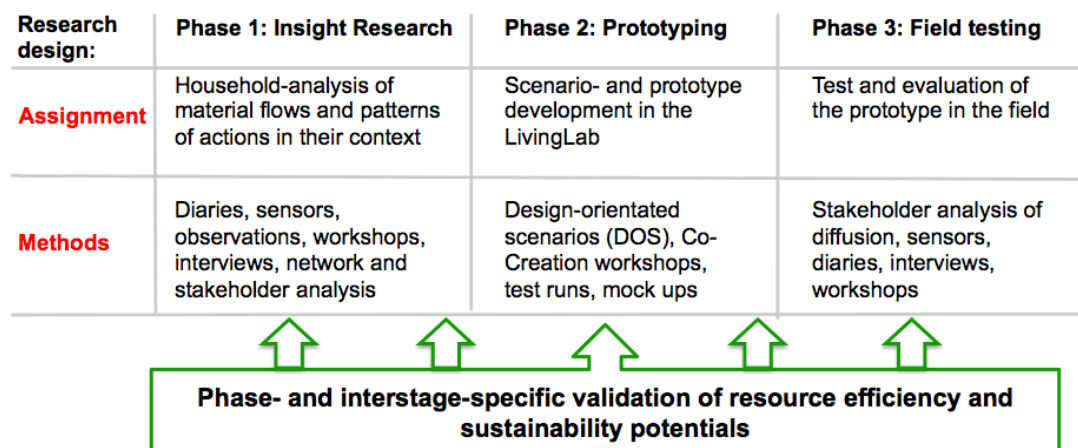
### Exploring research models for Sustainable LivingLabs in a case study<sup>4</sup>

The project “SusLabNWE - Creation of a networked infrastructure for innovation on sustainability in the home environment that enables user-centred testing and development in living laboratories” is conducted in a joint-project of research facilities and stakeholder partners across Europe (2012-2015), funded by the European Regional Development Fund (ERDF), Programme INTERREG IVB NWE. It aims to set up a networked infrastructure of houses and LivingLabs in North-West Europe at five locations: Rotterdam (NL), Ruhr area (DE), London (UK), Gothenburg (SE) and Zurich (CH). Each location will be set-up according to the results of the Design Study on LivingLabs and run in public-private partnership. Companies, researchers and policymakers will be able to collaborate in these

<sup>4</sup> This section is mainly based on Liedtke et al. (2012c).

multi-disciplinary, user-centred testing facilities in order to increase household's sustainability.<sup>5</sup>

The focus area of the German consortium within the SusLabNWE Project<sup>6</sup> (Wuppertal Institute, Hochschule Ruhr West and InnovationCity Management GmbH) is located in the Ruhr area in North Rhine-Westphalia. Several districts of the city of Bottrop, all together an area with approximately 67,000 inhabitants, have been nominated as the model region 'InnovationCity Ruhr'<sup>7</sup>, and is as such participating as one of the five locations in the SusLabNWE project. Different initiatives aim to reduce CO<sub>2</sub>-emissions by 51 % until 2020. In the field of heating alone a cut of consumption from 829 GWh now to 409 GWh in 2020 is aspired. The project – co-financed by the Ministry of Innovation, Science and Research of the German Federal State North Rhine-Westphalia – aims at building up a LivingLab infrastructure here and, thus, contributing to this ambitious transition process by setting up a pilot application in the area of heating and cooling in InnovationCity Ruhr. Approximately 80% of all heating systems in Germany work inefficiently and consume too much energy. Combined with optimising user behaviour, savings of 10-30% of heating energy are possible (Messerschmidt 2012). The following Figure 2. gives an outline of how the Three-Phases Model of research is adopted and employed in the SusLabNWE project.



**Figure 2: The Three-Phase Model of Research in Sustainable LivingLabs (Liedtke, Geibler and Greiff, based on Green and Vergragt 2002; Bakker et al. 2010)**

**First Phase - Insight Research:** Point of departure is an in-depth analysis of material flows and patterns of action within households. For InnovationCity Ruhr, user behaviour will be analysed in 20-50 households of the area using qualitative and quantitative research methods, and focussing on heating. Methods include i.e. qualitative interviews or installing temporary data loggers for temperature and air quality in the households. A network and stakeholder analysis on who are relevant actors in the heating system for the area, as well as workshops with producers on heating 2.0 will be conducted. This research will be conducted in the real-life environment of people's homes, thus it is possible to scrutinise the household's consumption and patterns of action in their actual context.

**Second Phase - Prototyping:** In this second phase the actual testing in the Sustainable LivingLab infrastructure is carried out. Lead-user and non-lead-user groups will be identified

<sup>5</sup> For more information on the overall project: [http://www.nweurope.eu/index.php?act=project\\_detail&id=4203](http://www.nweurope.eu/index.php?act=project_detail&id=4203)

<sup>6</sup> For more information on the German project:  
[http://www.wupperinst.org/projekte/proj/index.html?projekt\\_id=426&bid=29](http://www.wupperinst.org/projekte/proj/index.html?projekt_id=426&bid=29)

<sup>7</sup> <http://www.bottrop.de/microsite/ic/>

and open innovation and co-creation workshops will be performed by Fraunhofer inHaus, an existing research facility in the area and capable for the LivingLab infrastructure. Development of design-oriented scenarios, test runs with new prototypes as well as user-integration with mock ups in Fraunhofer inHaus are focus areas to employ the Sustainable LivingLab infrastructure within the research project. Furthermore, qualification tools and materials with a focus on the interaction of actors along the whole value chain of heating will be developed.

**Third Phase - Field Testing:** As a third step in the research process, fully functional prototypes will be tested and evaluated in the field, installing them in existing or newly built homes. Similar to the first phase, another stakeholder analysis of the diffusion for the newly developed prototype can be conducted as well as further in-depth tests in terms of sensoric observations. Again, quantitative methods, i.e. measuring potentials for energy savings, and qualitative research methods like interviewing users and stakeholders along the value chain can be combined.

During the development process a phase- and interstage-specific validation of resource efficiency and sustainability potentials of the new prototype is performed. By these means, sustainability assessment along the value chain is integrated throughout the Sustainable LivingLab approach. By doing so, necessary re-adjustments can be done at any stage of the open innovation process. At these stage, however, differences in data availability for a new prototype have to be regarded when conducting sustainability assessments. Especially for second order effects (technology application), data availability is more limited in the beginning of an innovation process since applications of developed products or services might only become apparent in the future (Geibler et al. 2006). Throughout the research process, time for reflection and learning processes is provided, thus, supporting future developments in the LivingLab's infrastructure in the sense of learning loops.

## 6. Conclusions

In this paper we have described a Sustainable LivingLab research infrastructure as a means to put users on centre stage in the innovation process of new sustainable products, services or models of supply. The Sustainable LivingLab approach enables design and development in such a way that user behaviour and social practices can be aligned with technological aspects for a more sustainable consumption and more sustainable value chains. By actively involving users and other important stakeholders in the innovation process, the potentials of diverse perspectives can be used and observing the practical application of innovations becomes possible. By these means, Sustainable LivingLabs can contribute to a necessary change in structures and processes both bottom-up (by sustainability innovations showing high user acceptance and less rebound effects) as well as top-down, e.g. by inducing a change in existing patterns of innovation and structures of energy supply. Developing a research infrastructure based on SLL will be challenging, as the case study in Germany and identified barriers highlight. There is a need to further explore the potentials and pathways for a Sustainable LivingLab infrastructure, both for companies that can benefit from more successful innovations and society that can benefit from more sustainable innovations and increased resource efficiency. Collaboration for sustainable consumption can be found in the collaboration of different stakeholder groups and users in innovation processes of new products or services. Overcoming key barriers and institutionalising this form of innovation process is likely to contribute to sustainable development.

## References

- Ahaus, B. Heidbrink, L. Schmidt, I., 2011. *Der verantwortliche Konsument. Wie Verbraucher mehr Verantwortung für ihren Alltagskonsum übernehmen können*. Working Paper No. 10/2011 of the Centre for Responsibility Research at KWI, Essen.
- Baedeker, C.; Liedtke, C.; Welfens, J.; Busch, T. et al., 2005. *Analyse vorhandener Konzepte zur Messung des nachhaltigen Konsums in Deutschland einschließlich der Grundzüge eines Entwicklungskonzeptes*. Project report. Wuppertal Institute, Wuppertal.
- Bakker, C. et al., 2010. *LivingLab: Summary Report*. forthcoming.
- Barbier, E.B., 2009. *A Global New Deal*. Report prepared for the Economics and Trade Branch, Division of Technology, Industry and Economics, UNEP. Laramie: University of Wyoming.
- Bourdieu, P., 1977. *Outline of a Theory of Practice*. Cambridge: Cambridge University Press.
- Bourdieu, P., 1979. *Distinction: A Social Critique of the Judgement of Taste*. London: Routledge.
- Brand, K. W., 2010. Social Practices and Sustainable Consumption: Benefits and Limitations of a New Theoretical Approach. In: M. Gross and H. Heinrichs, eds. *Environmental Sociology: European Perspectives and Interdisciplinary Challenges*. Dordrecht/Heidelberg/London/New York: Springer, pp. 217-234.
- Chesbrough, H.W., 2003. *Open Innovation: the new imperative for creating and profiting from technology*. Boston: Harvard Business School Publishing.
- Chesbrough, H.W., 2006. Open Innovation: A New Paradigm for Understanding Industrial Innovation. In: H.W. Chesbrough, W. Vanhaverbeke and J. West, eds. *Open Innovation: Researching a new paradigm*. New York: Oxford University Press, pp. 1-14.
- Clark, W. C. Crutzen, P. J. and Schellnhuber, H. J., 2004. Science for global sustainability. In: Schellnhuber, H. J. et al., eds. *Earth system analysis for sustainability. Dahlem Workshop Report 91*. Cambridge: MIT Press, pp. 1-28.
- Clausen, J. Fichter, K. and Winter, W., 2011. *Theoretische Grundlagen für die Erklärung von Diffusionsverläufen von Nachhaltigkeitsinnovationen*. Borderstep Institut für Innovation und Nachhaltigkeit, Berlin.
- de Ridder, W., 2005, *SustainabilityA-Test Inception report*. Report no 555000001 from the Netherlands Environmental Assessment Agency. Available at: <http://www.rivm.nl/bibliotheek/rapporten/555000001.pdf> (last access 29 May 2012).
- Diehl, B., 2011. Nachhaltigkeitsinnovationen im Bedarfsfeld Wohnen. In: F.M. Belz, U. Schrader and M. Arnold, eds. *Nachhaltigkeitsinnovationen durch Nutzerintegration*. Marburg: Metropolis, pp. 121-144.
- Druckman, A. Chitnis, M. Sorell, S. and Jackson, T., 2011. Missing carbon reductions? Exploring rebound and backfire effects in UK households. In: *Energy Policy*, 39(6), pp. 3572-3581.
- ETC/SCP, 2009. *Environmental Pressure from European Consumption and Production*. ETC/SCP Working Paper 1/2009, European Centre on Sustainable Consumption and Production. Copenhagen.
- Geels, F.W. and Schot J.W., 2007. Typology of sociotechnical transition pathways. *Research Policy*, 36(3), pp. 399-417.
- Geibler et al. (2012): Ergebnisbericht im Projekt „Nachhaltigkeitsinnovationen im LivingLab. Ergebnisse der „Analysen zu Umsetzungsbedingungen“, Arbeitsschritt 2.2 des Arbeitspaketes 2.2: „Potenzialanalyse von Nachhaltigkeitsinnovationen durch LivingLabs“. Forthcoming.

- Geibler, J.v. Kristof, K. and Bienge, K., 2010. Sustainability assessment of entire forest value chains: Integrating stakeholder perspectives and indicators in decision support tools. In: *Ecological Modelling*, 221(18), pp. 2206-2214.
- Geibler, J.v. Liedtke, C. Wallbaum, H. and Schaller, S., 2006. Accounting for the social dimension of sustainability. Experiences from the biotechnology industry. In: *Business Strategy and the Environment*. Special Issue *Sustainability Accounting*, 15(5), pp. 334-346.
- Giddens, A., 1984. *The Constitution of Society: outline of the Theory of Structuration*. Berkeley/Los Angeles: University of California Press.
- Green, K. and Vergragt, P., 2002. Towards sustainable households: a methodology for developing sustainable technological and social innovations. In: *Futures*, 34(5), pp. 381-400.
- Hassenzahl, M. Prinz, W. Buchholz, H. and Laschke, M., 2011. Zwischen Können und Tun liegt ein großes Meer und auf seinem Grunde die gescheiterte Willenskraft. In: *i-com*, 10(2), pp. 1-2.
- Heidbrink, L. Schmidt, I. Ahaus, B., eds., 2011. *Die Verantwortung des Konsumenten. Über das Verhältnis von Markt, Moral und Konsum*, Frankfurt/New York: Campus.
- Heidecker, S. Diefenbach, S. Creutz, P. Laschke, M. and Hassenzahl, M., 2010. Transformationale Produkte: Erleben und wahrgenommene Veränderungspotentiale. In: J. Ziegler and A. Schmidt, eds. *Mensch & Computer 2010. Interaktive Kulturen*. München: Oldenbourg Verlag, pp. 195-204.
- Jackson, T., 2005. *Motivating Sustainable Consumption. A Review of Evidence on Consumer Behavior and Behavioral Change. Report to the Sustainable Development Network*. Available at: <https://www.c2p2online.com/documents/MotivatingSC.pdf> (last access 29 May 2012).
- Kemp, R. and Loorbach, D., 2006. Transition management: a reflexive governance approach. In: J.-P. Voss D. Bauknecht and R. Kemp, eds. *Reflexive Governance for Sustainable Development*. Cheltenham: Edward Elgar, pp. 103-130.
- Klöpffer, W. and Renner, I., 2007. Lebenszyklusbasierte Nachhaltigkeitsbewertung von Produkten. In: *Technikfolgenabschätzung - Theorie und Praxis* 16(3), pp. 32-38.
- Kotakorpi, E. Lähteenoja, S and Lettenmeier, M., 2008. *Household MIPS: natural resource consumption of Finnish households and its reduction*. The Finnish Environment 43en/2008. Ministry of Environment, Environmental Protection Department, Helsinki.
- Laschke, M. Hassenzahl, M. and Diefenbach, S., 2011. *Things with attitude: Transformational Products*. Create11 Conference (pp. 1-2), [online] Available at: [http://www.create-conference.org/storage/create11papersposters/Things with attitude.pdf](http://www.create-conference.org/storage/create11papersposters/Things%20with%20attitude.pdf) (last access 29 May 2012).
- Leimeister, J.M., 2010. Collective Intelligence. In: *Business and Information Systems Engineering*, 4/2010, pp. 245-248.
- Lewin, K. Lewin, G.W. and Frenzel, H.A., 1953. *Die Lösung sozialer Konflikte*. Bad Nauheim: Christian.
- Liedtke, C. et al., 2012a. *LivingLabs zur Integration von Nutzerverhalten und Nachhaltigkeit im Innovationsprozess*. Forthcoming.
- Liedtke, C. Welfens, M.J. Rohn, H. and Nordmann, J., 2012b. Living Lab: User-Driven Innovation for Sustainability. In: *International Journal of Sustainability in Higher Education*, 13 (2), pp. 106 - 118.

- Liedtke, C., Baedeker, C., Geibler, G.v.; Hasselkuß, M., 2012c. User-integrated Innovation: Sustainable LivingLabs Research and development of sustainable products and services through user-driven innovation. Paper presented at PERL International Conference “Beyond Consumption: Pathways to Responsible Living”, 19-20 March 2012 at the Technical University of Berlin, Germany.
- Loorbach, D., 2010. Transition Management for Sustainable Development: A Prescriptive, Complexity-Based Governance Framework. In: *Governance: An International Journal of Policy, Administration and Institutions*, 23(1), pp. 161-183.
- Mancini, L., Lettenmeier, M. Rohn, H. and Liedtke, C., 2011: Application of the MIPS Method for assessing the sustainability of production-consumption systems of food. In: *Journal of Economic Behavior & Organization, GDP to Well-being Special Issue*, 81(3), pp. 779–793.
- Messerschmidt, J., 2012. Smart Submetering für die Wohnungswirtschaft: Niedrig-intensive Maßnahmen zur Energieverbruachssenkung bei Gebäuden. In: *Energy 2.0 Kompendium 2012*, p. 99.
- Paech, N., 2005. Richtungssicherheit im nachhaltigkeitsorientierten Innovationsmanagement. In: Fichter, K. Paech, N. and Pfriem, R., eds. *Nachhaltige Zukunftsmärkte. Orientierungen für unternehmerische Innovationsprozesse im 21. Jahrhundert*. Marburg: Metropolis, pp. 323-347.
- Piller, F. Wagner, P. and Antons, D., 2012. Innovationsmanagement in der Energiebranche - Anwendung des Open Innovation-Ansatzes. In: H.-G. Servatius, U. Schneidewind and D. Rohlfing, eds. *Smart Energy: Wandel zu einem nachhaltigen Energiesystem*. Heidelberg/Dordrecht/London/New York: Springer, pp. 173-192.
- Project Group on the integration of social criteria into Life Cycle Assessment, 2008. *Code of Practice for a social-economical LCA (seLCA) for product assessment*. UNEP / SETAC Life Cycle Initiative. United Nations Environment Programme.
- Reckwitz A., 2002. Toward a Theory of Social Practices. *European Journal of Sociology*, 5/2002, pp. 243-263.
- Reichwald, R. and Piller, F., 2006. *Interaktive Wertschöpfung: Open Innovation, Individualisierung und neue Formen der Arbeitsteilung*. Wiesbaden: Gabler.
- Rip, A. and Kemp, R., 1998. Technological Change. In: S. Rayner and E.L. Malone, eds. *Human Choice and Climate Change. Two: Resources and Technology*. Columbus: Batelle Press, pp. 327-399.
- Rohn, H. Lettenmeier, M. and Pastewski, N., 2011. Identification of Technologies, Products and Strategies with High Resource Efficiency Potential: Results of a Cooperative Selection Process. In: R. Bleischwitz P.J.J. Welfens and Z. Zhang, eds. *International Economics of Resource Efficiency*. Heidelberg: Physica-Verlag HD, pp.335-347.
- Rohn, H., 2011. Ressourcenkultur: Untersuchung von Ressourceneffizienzinnovationen und Vertrauenskulturen in KMU als Beitrag für eine nachhaltige Entwicklung. In: K. Möslin et al. (eds). *Arbeit in Balance: flexibel, stabil, innovativ. Strategien für das 21. Jahrhundert*. Nürnberg: Institut für Wirtschaftsinformatik, pp. 12-13.
- Röpke I., 2009. Theories of practice: New inspiration for ecological economic studies on consumption. *Ecological Economics*, 68(10), pp. 2490-2497.
- Schaltegger, S.; Herzig, C.; Kleiber, O.; Klinke, T.; Müller J., 2007. *Nachhaltigkeitsmanagement in Unternehmen: Von der Idee zur Praxis*. Berlin and Lüneburg: BMU, econsense and CSM.

- Schelske, A., 2008. Transparente Märkte in interaktiven Wertschöpfungsprozessen. Synchroner Konsumforschung mit vernetzten Konsumenten. In: D. Schrage & M. R. Friederici, eds. *Zwischen Methodenpluralismus und Datenhandel. Zur Soziologie der kommerziellen Konsumforschung*. Wiesbaden: VS Verlag, pp. 167-191.
- Schneidewind, U.; Scheck, H.; Augenstein, K.; Baedeker, C.; Beuermann, C. et al., 2011. *Transitions towards Sustainability: Rethinking the Wuppertal Institute Research Perspective*. Internal Working Paper. Wuppertal Institute, Wuppertal.
- Spaargaren, G. Martens, S. and Beckers, T.A.M., 2006. Sustainable Technologies and Everyday Life. In: P.-P. Verbeek and A. Slob, eds. *User Behavior and Technology Development: Shaping Sustainable Relations Between Consumers and Technologies*. Dordrecht: Springer, pp. 107-118.
- Spaargaren, G., 2011. Theories of practice: Agency, technology, and culture. Exploring the relevance of practice theories for the governance of sustainable consumption practices in the new world-order. *Global Environmental Change*, 21, pp. 813-822.
- Spangenberg, J.H. and Lorek, S., 2002. Environmentally sustainable household consumption: from aggregate environmental pressures to priority fields of action. *Ecological Economics*, 43 (2-3), pp. 127-140.
- Surowiecki, J., 2004. *The Wisdom of Crowds: Why the Many are Smarter than the Few and How Collective Wisdoms Shapes Businesses, Economies, Societies and Nations*. New York: Doubleday and Company.
- Talwar, S. Wiek, A. and Robinson, J., 2011. User engagement in sustainability research. In: *Science and Public Policy*, 38 (5), pp. 379-390
- von Hippel, E., 1986. Lead Users: A Source of Novel Product Concepts. *Management Science*, 32(7), pp. 791-805.
- Walther, G., 2010. *Nachhaltige Wertschöpfungsnetzwerke. Überbetriebliche Planung und Steuerung von Stoffströmen entlang des Produktlebenszyklus*. Wiesbaden: Gabler.
- Warde, A., 2005. Consumption and Theories of Practice. *Journal of Consumer Culture*, 5(2), pp. 131-153.
- Welfens, M. J. Liedtke, C. and Nordman, J., 2010a. *Sustainable consumption: between unsustainable reality and people's willingness to act*. Paper presented at the ERSCP-EMSU Conference "Knowledge Collaboration & Learning for Sustainable Innovation", Delft, The Netherlands, October 25-29, 2010.
- Welfens, M.J. Liedtke, C. Rohn, H. and Nordmann, J., 2010b. *Living Lab: Research and Development of Sustainable Products and Services Through User-Driven Innovation in Experimental-Oriented Environments*. Paper presented at the ERSCP-EMSU Conference "Knowledge Collaboration & Learning for Sustainable Innovation", Delft, The Netherlands, October 25-29, 2010.

***Technological approaches for resource efficiency:  
Mapping international experiences and cases***

*Track 4c: Resource strategies:*

*Industrial ecology, waste management, material cycles, and life  
cycle analysis*

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## **Abstract**

Technological innovations including information and communication technologies, bio- and nanotechnologies can offer surprising solutions to a number of problems and are discussed as a possible key to achieve global sustainability goals. Nevertheless, there is growing evidence that technological innovations do not automatically contribute to sustainable development. A number of questions arise: How can the contribution of technological innovations to sustainability be assessed in the light of limited data availability and uncertainties of future developments and lack of application scenarios? How can information on promising innovations be identified and integrated within decision-making processes? How can more efficient products and technologies be mainstreamed in future markets?

The paper addresses these questions and focuses on resource efficient technologies as strategy to promote more sustainable development. Based on the theoretical concept of the industrial metabolism and material flow accounting, an input oriented approach to resource management and sustainability is suggested. A methodological framework for identifying technological innovations with resource efficiency potential is presented. Then, the presentation will highlight results from interdisciplinary research on resource efficiency cross-cutting different technological fields, from the project called “Resource Efficiency Atlas”. This project has been conducted at the Wuppertal Institute in cooperation with Trifolium, the University of Stuttgart and the Fraunhofer Institute for Industrial Engineering, funded by the German Federal Ministry of Education and Research. An overview of identified cases of resource efficient technological solutions, strengths and weaknesses of technology development as well as recommendations for improved mainstreaming of innovative resource efficient technologies and products will be presented. The results are based on an international survey of good practice examples and an intensive expert discourse. In the paper, the authors reflect their experiences of applied sustainability research on technological innovations and resource efficiency.

## **1. Introduction**

Resource efficiency has become an established component of sustainable management of natural resources. Using raw materials efficiently is desirable from ecological, social and economical perspectives. Rising prices and increasing uncertainty over the supply of natural resources is a concern for business worldwide. In addition, using resources inefficiently can cause competitive disadvantage and result in endangering jobs and the development of companies (Bundesministerium für Umwelt 2007). Concerns are rising that price hikes and raw material shortages will cause resource conflicts with devastating social and environmental effects. At the same time, intelligent solutions and strategies on resource efficiency are formulated, creating a wealth of knowledge and a wide skill base for implementing sustainable management of natural resources.

Therefore, improved resource efficiency is becoming an issue in international and national politics as well as in business. This is visible on the political agenda (EEA 2011). Examples of single policy initiatives are the strategy “Europe 2020”, where resource efficiency is one of the seven flagship initiatives (European Commission 2011), the Austrian resource efficiency action plan “REAP” (Bundesministerium für Land- und Forstwirtschaft, Umwelt und Wasserwirtschaft 2012), or the German national resource strategy “ProgRress” (BMU 2012). In addition, the German Enquete commission on growth, wealth, and quality of life focuses on the decoupling of wealth and resource use as central theme (Deutscher Bundestag 2011). Resource efficiency gains increasing acceptance within the context of the “Green economy” debate (OECD 2011; UNEP 2011). More and more companies start to look for resource efficient technologies (OECD 2009).

Improving resource efficiency is also necessary for not exceeding ecological boundaries on earth. The growth of primary material requirements of the society can be interpreted as increase in environmental pressure (Bringezu et al. 2009). The pressures on the environment caused by natural resource extraction and use, and by the emissions and waste generation, result in direct ecological problems. The global use of materials, metals, and minerals as well as fossil raw materials and biomass, has strongly increased over the past 30 years (Sustainable Europe Research Institute 2011). The use of resources is accelerated by the industrialisation in emerging countries. The global economy is expected to grow on average by three percent each year until 2030 (Bundesministerium für Umwelt 2007).

Research shows that resource efficiency can lead to lowering material purchasing costs throughout industry and enhance competitiveness. E.g. innovative applications in the fields of information- and communication technologies or bio- and nanotechnologies offer comprehensive solutions for the saving of resources. In the light of the ecological urgency to implement resource efficiency and existing cases of resource efficiency, the question arises why not more resource efficient technological solutions are applied. What are the obstacles for sustainable innovation in

technologies, products and strategies for resource efficiency to be applied? Which measures can be taken to aid their market entry and further distribution?

This paper addresses these questions based on an interdisciplinary research study on crosscutting different technological fields within the project called “Resource Efficiency Atlas” (REA). The project<sup>1</sup> has been conducted by the Wuppertal Institute, Trifolium, Fraunhofer Institute for Industrial Engineering and University of Stuttgart. It has been funded by the German Federal Ministry of Education and Research with the overall aim to identify and evaluate products and technologies with high resource efficiency potential (leading products and technologies) on a global level. In this, it is (among other methods) based on an international survey of good practice examples and an intensive expert discourse. In this paper, which is largely based on the English final report of the project (Geibler et al. 2011), the authors present key results and reflect experiences of applied sustainability research on technological innovations.

## **2. The approach: Identifying technological innovations with resource efficiency potential**

Today, mankind consumes much more resources than supplied by the Earth (Global Footprint 2009). Since 1980, global extraction of abiotic (fossil fuels, minerals) and biotic (agriculture, forestry, fishing) resources has augmented from 40 to 58 billion tones in 2005 (EU Parliament 2009). Considering the increasing prosperity of developing countries in the near future, especially the industrialized countries are required to reduce their resource consumption. Germany for instance would have to increase its efficiency by a factor of about ten (Schmidt-Bleek 2007).

In general, resource efficiency can be understood as the improvement of the ratio between desired output of a process and the related resource input. The narrow definition of the term “resource efficiency” comprises the efficient handling of four domains: material, energy, water and land use (Schütz and Bringezu 2008). The general principle of resource efficiency has been well known for a long time but well documented examples of successful implementation are rare. Comprehensive, global collections of resource efficiency technologies, products and strategies are lacking. For this reason the mentioned project REA was initiated.

Within the project, three key steps have been conducted in an iterative way: 1) the screening of technologies, products and strategies showing high resource efficiency potential, 2) the evaluation and selection of those and 3) the elaboration of the selected examples (figure 1). For this process, different methodologies like basic desk research and expert involvement (interviews, surveys and an expert workshop) have been combined. This approach resulted in the collection of almost 350 examples for resource efficiency measures as well as in expert input for

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<sup>1</sup> For more information see [www.ressourceneffizienzaltas.de](http://www.ressourceneffizienzaltas.de).

the development of a transition strategy. In the following, the three key steps are explained in detail.

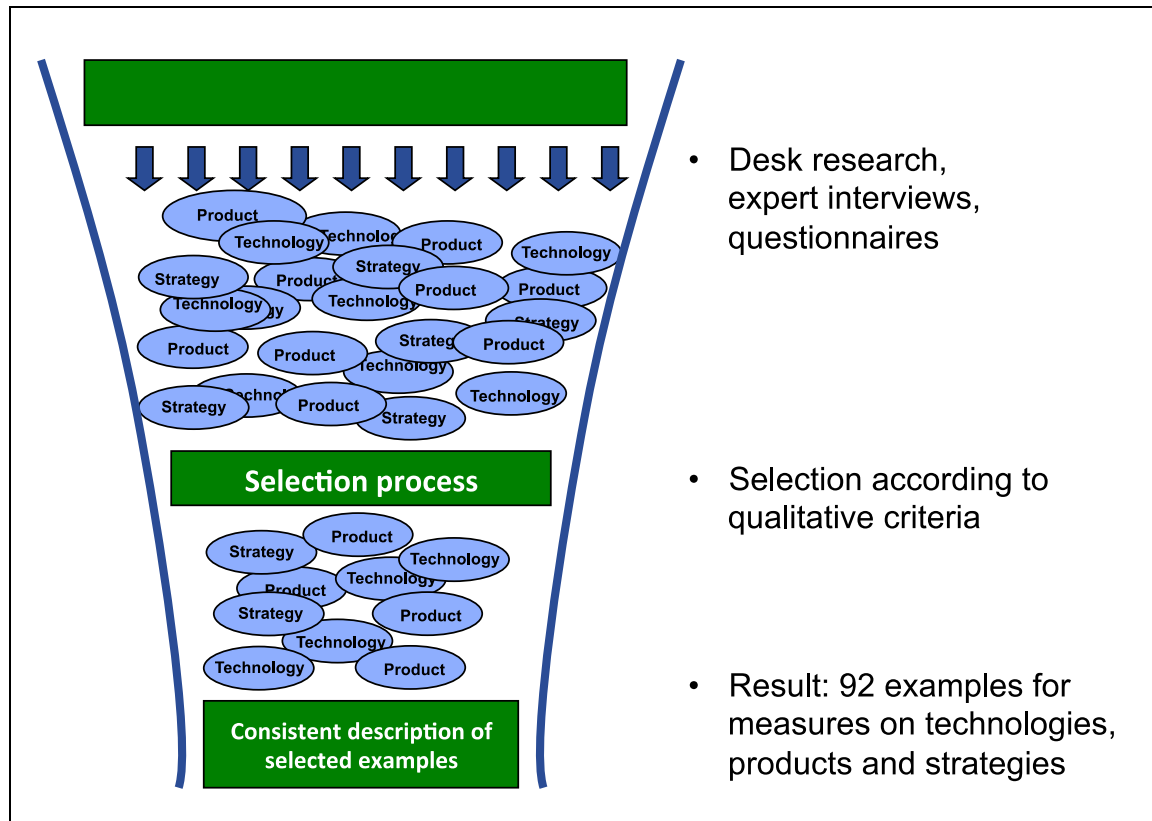


Figure 1: Methodology of screening and selection process (Source: Geibler et al. 2011)

In the first step – screening of technologies, products and strategies – a desk research for identifying measures with high resource efficiency potential was conducted. This included research, analysis and assessment of international literature as well as statements by stakeholders. Experts were asked to provide links referring to good practice examples. Beside this, multiple platforms for environmental technologies as well as relevant conferences in various countries were scanned. Also, questionnaires with the invitation to report on resource efficient measures were sent to companies in Europe and other selected countries.

The second step comprised the selection and the evaluation of the identified examples concerning their resource efficiency potential. First of all, the long list of identified technologies, products and strategies were assessed and reduced by using pre-defined qualitative criteria, such as environmental impact, feasibility, economic relevance, relevance for communication and transferability. Based on this, core topics were selected for the expert interviews. Following this, 17 international experts with either a practical application, research and development or a general background covering these core topics were selected and interviewed. Topics of the interviews were the understanding of the term resource efficiency, nomination of resource efficient measures within the particular fields of knowledge and estimations of their resource efficiency

potential as well as the development of measures in the future. Additionally, the interviewees were asked for assumptions concerning the realization of resource efficiency within the specific sectors. To discuss and validate the approach and results of the mapping process a workshop with external experts from research institutes and public institutions in the field of resource efficient technologies was held.

The last step aimed at a consistent description of the selected examples. Fields in which resource efficiency potentials can be expected were explored for technologies, products and strategies. Likewise, four domains were defined to illustrate resource efficiency effects: material, energy, water and area. Risks and opportunities were described, followed by a concluding assessment of the potential.

### **3. Selected results from the project “Resource Efficiency Atlas”**

In this section of the paper, selected results from the interviews with international experts and the search for resource efficient technologies and products are presented.

#### **Results from expert interviews**

As part of the project interviews were held with international experts. The purpose of these interviews was to obtain an overview of the general understanding of resource efficiency, main potentials, possible prospective developments and obstacles, and success factors in the implementation of resource efficiency in an international context. In total 17 interviews were conducted. Key results of the survey, based on the four interview sections “understanding and importance of resource efficiency”, “potential estimation of resource efficiency”, “possible future developments” and “cross-cutting themes“ as well as “implementation of resource efficiency”, are presented below:

##### *Understanding and importance of resource efficiency*

Within the context of major global challenges such as demographic trends, climate change, and resource scarcity, the interviews showed that resource efficiency is mainly considered as one of the key global strategies for economic activity. There is consensus on a tightened shortage of primary resources considering rapidly increasing demand for resources. There is a need for resource efficiency - a concept to achieve the same performance with geologically limited resources to serve the same number of people. The objective is to maximize the use of existing resources.

According to the interviewed experts, there are already a number of scientific publications and capabilities in various disciplines concerning this topic for decades. The publications illustrate possible instruments, methods, and solutions that can support the increase of resource efficiency at different levels. Even in the public debate, the issue is on the daily agenda. For this reason, most of the experts agree that responsible resource management is fundamental. However, there

are differences in opinions concerning questions of implementation and several focal points. Here, the regional and discipline-related interests are natural determinants.

Economic gains or benefits are key driving factors for resource efficiency. In many countries, there is concern about reducing dependencies on imported raw materials – hence, they secure the control of resources and their availability. Recent geo-political activities of several countries, such as China, which occupy strategic raw material deposits in the long term, generate large uncertainties. However, the pursued measures differ highly from each other depending on the type of resources. While the energy-related issues such as renewable energy or energy efficiency obtain wide recognition, material efficiency on the other hand has little importance in some areas. Some experts state that material efficiency is an important field of research, because it contains potentials beyond all value-chain phases from the development, production, removal up to recycling. Here, it is imperative to develop alternatives with long-term and lifecycle comprehensive perspectives. In the meantime, respectable efforts are needed to make additional use of alternative (secondary) sources for selected commodities, such as phosphorus and copper or strategically important and rare metals/earths. In some countries, especially in those with low fossil fuel reserves, the security of energy supply is directly connected with growth and wealth, which makes energy efficiency a top priority.

Increased efficiency associated with economic advantages is seen as economic motivation for resource efficiency. Thus, resource efficiency gains practical relevance due to high material and energy costs. An attempt is made to reduce the direct cost and to increase efficiency. Costs are a central control parameter for many companies, because only a few pursue a long-term non-price orientation. Considering the debate about companies developing towards greater resource efficiency, for example by using alternative technologies, companies especially require an effort-reduced and at the same time reliable decision support, in form of an assessment of available technologies. Most companies perceive sustainable economic activity to create “win-win-situations”. However, the global economy is still not use reflecting the actual cost of production, i.e. life-cycle-wide resource, on the prices. This non-reliable cost internalization remains a major problem for economies attempting to achieve resource efficiency.

#### *Potential estimations for key areas*

The experts confirm the high importance of technologies to reduce the use of resources worldwide. Disagreement is only present concerning range and stimuli of change of a solely or mainly technology-oriented focus. Consensus is reached among all experts on the outstanding resource efficiency potentials of the technology fields introduced in chapter 3. However, technologies can only develop their full potential if the underlying framework provides suitable conditions. Most experts consider two different approaches for saving resources. First of all, it is possible to develop relevant technologies. Secondly, technical applications for a particular area can be developed. For example, information and communication technology (ICT) helps new

generations of computers to consume even less energy and require fewer resources in the field of “Green IT”. On the other hand, ICT also supports increased energy efficiency by using an intelligent control of power supply (smart grid) from different sources. In this context, the experts mention particularly relevant priority fields for which special solutions should be developed.

#### *Possible future developments and cross-cutting issues*

The previously mentioned priority areas and related issues are likely to remain significant in the future. In some cases, new areas will evolve or create entirely new tasks. Corresponding developments are related to changing conditions. Thus, mega-trends such as population growth and urbanization as well as an increasing flexibility in the way of life will have a strong influence on needs, which in turn must be satisfied by technology. In the near future – in ten years or more – the following issues will gain in importance according to the experts:

- Converging technologies
- Food/Nutrition
- Resource efficiency technologies to mitigate climate change
- Water efficiency
- Decentralization and social networks

#### *Implementation of resource efficiency*

The interviewed experts agree on the fact, that resource efficiency is an important issue, though obstacles and success factors for implementation need to be considered. Thus, at the beginning of implementing measures, decisions have to be made for which a solid information base is needed. This information should be carefully analysed focusing on issues such as, for example, cost, availability of personnel and financial resources (e.g. are the home owners financially capable of and willing to make their home more energy efficient?). Some decision-making processes should be made automatically instead of leaving it to the home owners, as people often do not act in line with optimal efficiency. For example, the choke used in automobiles was handled manually in the past and more inefficiently than it is controlled nowadays (automatic). The experts emphasize that the implementation of resource efficiency depends on economic, structural and geopolitical conditions.

#### **Cases of resource efficient technological solutions**

Within the project, the results of the screening process (approx. 350 examples) were evaluated. Relevant examples (21 cases) were selected for a print publication (Geibler et al. 2011) as well as for the internet (92 cases). All examples were graded based on a scale from one to six, where one represented best suitability for the atlas. This meant, the following criteria were considered: high potential for resource efficiency, good informational background, economical relevance, environmental impact, feasibility and transferability. In order to obtain a unanimous rating as

basis for selection, all project members conducted the grading, upon which the results were discussed.

During the assessment of the resource efficiency potential numerous challenges occurred; i.e. little quantifiable data on sustainability effects are available. Whereas, for example, technical data in the early development stages are often available from provider, only assumptions can be made about the use-phase or possible rebound effects. Therefore, even if sustainability effects cannot be measured, foreseeable risks and opportunities should be at least mentioned in the Resource Efficiency Atlas.

Aiming at collecting approx. 90 to 100 examples, from almost 350 collected examples, only examples with grades one and two were selected for the “Resource Efficiency Atlas”. These were then thoroughly researched and in certain cases commented on by the manufacturer or developer. Thus, the majority of examples are based merely on own research, excluding a few submitted examples. Overall, the global mapping resulted in a description of 92 efficient technologies, products and strategies. According to the scope of the research most identified measures are located in Europe, Asia and North America. The share of the identified measures is highest in technologies, followed by products and strategies (figure 2).

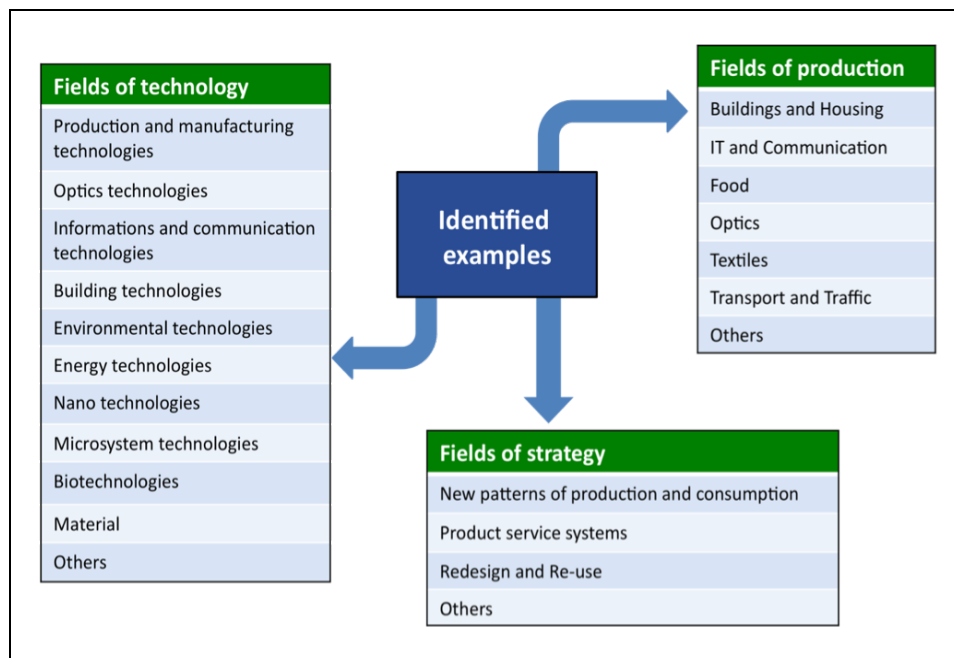


Figure 2: Results of the global mapping: Overview of key fields for resource efficient measures (Source: Geibler et al. 2011)

The selected examples were described in a consistent manner. Hence, for each identified technology, product, and strategy the resource fields of potentially improved efficiency in material, energy, water, and surface fields were selected. According to these fields a qualitative



analysis about resource efficiency was performed and as far as data could be researched a rough estimate in quantitative terms followed as well. Consequently, a description about the chances and risks as well as potential appraisal was conducted). To illustrate the description of cases in the Resource Efficiency Atlas, the following box describes one arbitrarily selected example from the technology field in a condensed form (Box 1).

**Example Seawater Greenhouse:****The natural water circulation as model for the future greenhouse**

The functionality of conventional greenhouses is reversed in the Seawater Greenhouse. Here, seawater serves as cooling system of the greenhouse allowing for the cultivation of vegetables and fruits even in dry regions, which normally are unsuitable for crop cultivation. The necessary water is obtained via an integrated seawater desalination plant.

The water demand of the Seawater Greenhouse can be covered with the help of a solar powered seawater desalination plant. Hence, it is particularly suitable for dry, coastal regions. In the Seawater Greenhouse, a simulation of the natural water circulation takes place. Apart from serving as climate control within the greenhouse, this principle allows for the transformation of seawater into fresh water, which is used for irrigation of the plants. In addition, plantations outside the greenhouse with fruits like oranges or lemons can be watered. Furthermore, minerals from the seawater are used for the fertilization of the crops as well as for the production of salt crystals.

The concept of the Seawater Greenhouse has been developed by Charlie Paton in England and further researched by the British enterprise Seawater Greenhouse Ltd. since 1991. By the end of the 90ies it was ready to be launched. In 1992, a first pilot plant was set up on the Canary Island Tenerife. Positive results confirmed the capacities for development and, thus, suggested application in other regions. Other research facilities ensued. The first Seawater Greenhouse in the world used for commercial purposes was opened in South Australia in 2009.

**Resource efficiency:** The solar powered desalination of seawater represents an eco-friendly and energy-saving alternative to conventional seawater desalination plants. The obtained fresh water is pure and distilled and requires no further chemical treatment. Groundwater withdrawal is minimised due to production of the necessary fresh water. The use of pesticides can be reduced or even completely avoided by using the "germ-free" evaporated seawater. For these processes only solar- and wind energy is used. The salt, which is won during the desalination process, can be sold as table salt – as long as it is economically viable. Other minerals obtained in this process are used for fertilization.

**Barriers and risks:** The investment volume of solar powered seawater desalination plants is high. Therefore, there is a serious risk of creating dependencies on the desalination industry, especially in poor countries. Furthermore, taking other environmental protection measures, for

example improving the water management system, might not be given priority due to the use of seawater desalination.

Potential environmental risks of seawater desalination have not been thoroughly assessed yet. Returning the filtered salt as brine into the sea can have negative effects on the already disturbed coastal regions. This is one of the major concerns of the environmental organisation WWF. They warn about the destruction of coastal regions. Supporters of the desalination technology argue, that the conditionally increased salt concentration of 6.5 - 7 percent caused by the refeed is not measurable already within a few meters from the point of discharge into the sea.

**Potentials:** In 2008, the manufacturer Seawater Greenhouse developed together with a team of architects the concept of the Sahara Forest Project. This project is a further development of the Seawater Greenhouse concept and intends to use large-scaled greenhouses together with solar plants for the food production in deserts. Solar tower power stations not only supply the energy needed for the pumps installed in the greenhouses but also support the evaporation process of the sea water due to their heat waste. The plants are expected to produce a surplus of energy and drinking water.

**Further information:**

- Davies and Paton (2005): The Seawater Greenhouse in the United Arab Emirates: thermal modelling and evaluation of design options, *Desalination* 173, 2, 103–111.
- Seawater Greenhouse Limited, 2a Greenwood Road, London E8 1AB, UK, [www.seawatergreenhouse.com](http://www.seawatergreenhouse.com)

While gathering relevant examples, a number of insights were gained. They can be summarised as follows (Geibler et al. 2011):

- There is a multitude of examples available varying from high to low tech, from an idea to already established/developed product/method, from partial solution to a complete system. The examples cover many application fields including examples with high resource requirements (transportation or building and housing). There is an above average amount of energy efficiency examples.
- Although the spectrum of examples is very wide, there is little variance in regards to the origin of the countries of the examples. This could indicate potential leading countries or regions in the field of resource efficiency. However, based on the amount of chosen examples and the regional focus of the research, no valid general statements about regional innovation forces can be made.
- Only very few examples are described comprehensively, especially outside of Europe. An exception to this is Japan, however, here the greater focus is on energy efficiency. The European technology platforms provide only limited information on specific example descriptions and resource efficiency potential.

- The evaluation is often not quantified or only based on manufacturer's data. The potential of a specific application is only described at a very generic level, if at all. Very differing methods are used to determine and describe the potentials for resource efficiency.
- Constraints and risks such as rebound-effects are usually left out. This is true not only for the manufacturer information, but also for already existing resource efficiency example websites.
- The selected 92 examples for the "Resource Efficiency Atlas" have their main focus in the field of technologies on: production and manufacturing technologies, energy technologies, and materials; in the field of products on: buildings and housing and in the field of strategies on: redesign and re-use as well as new production and consumption patterns.
- Information on certain cases, for example from the Asian region, were only available in their native language. This largely limits their international diffusion. They could be translated for the Resource Efficiency Atlas only in exceptional cases.

### **Strengths and weaknesses of resource efficiency technologies**

In order to identify strengths, weaknesses, opportunities, and threats of "technical solutions for increasing resource efficiency" a SWOT-analysis was conducted from a technology and product development perspective. The project experiences are summarised by means of the SWOT-analysis against the background of accelerated resource efficient technology and product development. A particularly important issue is related to advantages and disadvantages coming along with a focus on resource efficiency during technical solution development. For this purpose, strengths and weaknesses of technology and product development (internal perspective, table 1) as well as opportunities and threats - with regard to framework conditions for development (external perspective, table 2) - are considered. This assessment is based on a cross-analysis of results derived from expert interviews and example collection. Furthermore, observations from the research process are included to ensure a comprehensive analysis.

The internal perspective on technology and product development indicates that some companies profit already today by focusing on resource efficiency during technology development. These companies gain from lower price risks and improved supply conditions. In addition, companies can profit from a positive image of resource efficiency allowing them to open up new markets. With respect to the production process, resource efficiency can lead to cost savings if, for example, material savings and waste prevention are implied. However, this is not always the case: For instance, material substitution might lead to a lower amount of material input due to higher stiffness. Still, total costs of production might increase because of higher material costs.

Table 1: Strengths and weaknesses of technical solution development for increasing resource efficiency (internal perspective) (Source: Geibler et al. 2011)

<b>Strengths</b> Which strengths are apparent in the development of resource efficient technologies and products?	<b>Weaknesses</b> Which weaknesses are apparent in the development of resource efficient technologies and products?
<p><b>Future-oriented development</b></p> <ul style="list-style-type: none"> <li>- Considering the increasing scarcity of resources and avoiding potential supply shortages</li> <li>- Development of innovative products and stabilisation of the German economy</li> </ul> <p><b>Opening up new markets</b></p> <ul style="list-style-type: none"> <li>- Opportunities for new marketing strategies</li> <li>- Market differentiation in a green segment</li> </ul> <p><b>Economic incentives</b></p> <ul style="list-style-type: none"> <li>- Process optimization and cost avoidance for waste treatment</li> <li>- Saving material and energy costs</li> <li>- Benefits from existing promotion measures</li> </ul> <p><b>Improved communication</b></p> <ul style="list-style-type: none"> <li>- Internal communication and workforce motivation</li> <li>- Possibilities for improving public image</li> </ul>	<p><b>Missing cooperation and initiatives for resource efficiency</b></p> <ul style="list-style-type: none"> <li>- Ecological initiatives focus on energy issues and climate change</li> <li>- Insufficient networking for resource efficiency</li> </ul> <p><b>Missing funding sources</b></p> <ul style="list-style-type: none"> <li>- High investment costs for technology and product development are often an obstacle</li> <li>- Avoidance of external costs in the production process is often economically not feasible for businesses</li> </ul> <p><b>Missing competencies</b></p> <ul style="list-style-type: none"> <li>- Limited use of resource efficiency assessments and practical implementation</li> <li>- Shortage of skilled workforce</li> <li>- Implementation of sustainability assessments particularly with respect to human toxicity, long term availability and social aspects (e.g. rare earths)</li> <li>- Necessary restructuring of processes within businesses and along the supply chain</li> </ul>

A key obstacle towards resource efficient technology development is the necessary investment cost primarily paid for by the manufacturer. In many cases the production process becomes more expensive as well: One example is the production of hybrid cars, which are more expensive than comparable vehicles. They also require higher resource use during the production process. The price premium is passed on to customers as they benefit from lower fuel consumption. Due to the high investment costs for this kind of innovations the demand is limited.

Another obstacle might be the relevance of other sustainability themes. Resource efficiency is only one issue within the holistic perspective of sustainability. Important expertise is often missing such as assessment with expanded indicator systems in the development stage to account for specific environmental impacts (e.g. soil acidification, human toxicity, and social criteria). Any consideration should address the demand for critical raw materials such as rare earths, as, for example, a resource optimized production process might increase the use of rare earths. In the light of anticipated shortages on the world market the use of rare earths is risky and can counteract technology diffusion.

A prerequisite for the development of resource efficient solutions is the availability of appropriate competences in research institutions and companies. This is a challenge, as innovative technologies require novel know-how and, thus, new professional qualifications. Therefore, training and further qualifications might be necessary.

Table 2: Chances and risks of technical solution development for increasing resource efficiency (external perspective) (Source: Geibler et al. 2011)

<b>Opportunities</b> Which opportunities arise from development of resource efficient technologies and products?	<b>Threats</b> Which risks arise from the development of resource efficient technologies and products?
<p><b>Improved environmental impact</b></p> <ul style="list-style-type: none"> <li>- Resource savings tend to reduce multiple environmental impacts (e.g. reduction of land use intensity, material and water savings, reduced greenhouse gas emissions).</li> <li>- Exploiting potentials for cost savings across different sectors.</li> <li>- Efficiency potentials exist in branches of production with high resource use (e.g. construction industry, energy supply).</li> </ul> <p><b>Competitiveness of Germany</b></p> <ul style="list-style-type: none"> <li>- The development of resource efficient products strengthens Germany's dominant position in the field of environmental technologies.</li> <li>- The export of resource efficient technologies can act as a growth engine.</li> <li>- Creation of attractive and long-term employment.</li> <li>- Lowering the dependency on resource rich countries.</li> </ul> <p><b>Responsibility for future generations</b></p> <ul style="list-style-type: none"> <li>- Preservation of resources for future generations (inter-generational justice).</li> </ul> <p><b>Political strengthening of resource efficiency</b></p> <ul style="list-style-type: none"> <li>- Reorganisation of financial subsidies at state, federal and EU level.</li> <li>- Support of political programmes such EU2020-Strategy Flagship Initiative Resource efficiency.</li> </ul>	<p><b>Resource efficiency as a niche market</b></p> <ul style="list-style-type: none"> <li>- Saving effects of natural resources linked to commercial success / product diffusion.</li> <li>- The higher prices caused by increasing development costs can negatively affect the purchasing decision of cost aware users.</li> </ul> <p><b>Appearance of rebound effects</b></p> <ul style="list-style-type: none"> <li>- Danger of shifting resource requirements to other lifecycle stages.</li> <li>- Rebound effects are partly difficult to deal with during product development.</li> </ul> <p><b>Multitude of assessment approaches</b></p> <ul style="list-style-type: none"> <li>- No established assessment standard for resource efficiency is existent. This restricts the comparability of different businesses, products and technologies.</li> </ul> <p><b>Behavioural patterns and mind set</b></p> <ul style="list-style-type: none"> <li>- Inflexible mind set structures counteract needed changes towards resource efficiency.</li> <li>- Lack of consumer and supplier demand.</li> </ul>

From an external perspective, the development of resource efficient technologies opens up fundamental opportunities to minimize the environmental impacts within and beyond national boundaries. The corresponding effect is much stronger if the developed technology is widely diffused and / or used in resource intensive sectors.

Furthermore, increasing resource efficiency can reduce the dependency on imported raw materials. This is particularly important because Germany as a resource poor country has to import many of its raw materials.

It needs to be stressed that the development of resource efficient solutions has positive effects on the German economy, too. A reduction of material requirements can lead to significant cost savings. Within the MaResS-project it has been calculated that the gross domestic product (GDP) could increase by 14 percent through a higher resource efficiency on company level driven by specific information campaigns and consulting activities in 2030 (Distelkamp et al. 2010). A linear reduction of material and energy costs by 20 percent could create 700,000 new jobs in ten years according to a scenario study conducted by the Aachener Stiftung Kathy Beys (2006). As a result, gross domestic product could increase by 10 percent and state budget could be unburdened by approximately 20 billion Euros.

Viewed from a global perspective, reducing resource requirements might be positive for meeting the needs of future generations. Accordingly, there is a high political relevance of developing resource efficient solutions. This has been emphasised by the European Commission as resource efficiency is one of the seven flagships in the "Europe 2020" strategy .

The reduction of resource requirements through technologies is a complex theme. This is illustrated by some external threats: One major problem is due to the fact that a reduction of resource requirements at business level cannot necessarily be equated with total resource savings by businesses. The rebound-effects were often identified as a potential obstacle during the assessment of examples. Furthermore, the examples indicate that rebound-effects are a complex problem to deal with. Potential factors that might lead to rebound-effects should therefore be identified and addressed at an early development stage. Moreover, technology development should be optimized accordingly. In many cases relying on isolated technology development optimization will not be sufficient to prevent rebounds. Political measures are needed to counteract these effects through changed consumption behaviour.

From an environmental perspective another threat is that the spread of some resource efficient technologies and products might be restricted due to their very specific field of application. Technologies saving resources during the use phase are unlikely to realize their full potential if sold only in niche markets. This factor should be taken into account when promoting resource efficient technologies and products.

The same holds for technical solutions with high investment costs. The risk derives from the solution remaining in a niche market even if the use is economically feasible in the long run. Therefore, appropriate forms of promotion and funding need to be implemented by policies to counteract these risks.

In general, the results of the SWOT-analysis show that resource efficient technologies and products can only reach their full potential when framework conditions promote their use and their application aims at environmental improvements. In order to meet these conditions

corresponding changes of political framework conditions are needed. This includes promotion and funding opportunities allowing manufacturers and users to make the required investments. Labels indicating resource efficient products, or other ways of information, can create incentives for consumers. For this purpose, the current public debate focusing on climate and energy issues should be expanded to material and resource efficiency. This is also postulated by the majority of interviewed experts.

#### **4. Conclusions**

The results of the project show that the worldwide identification of existing and potential technologies for resource efficiency is achievable since they are available and more or less documented. A number of challenges remain to be addressed.

##### **Promote existing technology application – use potential**

Many technological innovations that could help sustainable development are economical and ready to be applied. More information and consultation is necessary to overcome the behavioural patterns that hinder practical application on a wider scale.

##### **Aid market entry of innovative resource efficient technologies and products**

Resource efficient technologies and products need support to enter the market. Targeted investment and subsidised pilot projects are a possibility to aid market entry and distribution. Pilot projects consequently require promotion in order to be able to up-scale and become mainstream technologies, products or processes. A key here is to integrate the concepts of resource efficiency and sustainability in the description of projects to gain a wider exposure for potential investment.

##### **Develop educational and research networks internationally**

In order to strengthen the development and mainstreaming of resource efficient technologies and products, educational cooperation networks should be strengthened. An example of such an initiative is the network of Cleaner Production Centres by the Cleaner and Sustainable Production Unit of the United Nations Industrial Development Organization (UNIDO). Collaborative initiatives for example by the leading polytechnic universities in Germany (TU9) could be utilized here. Efforts should include increasing the curricular to offer more resource efficiency related courses. Furthermore the number of research grants and university chairs in the resource efficiency area should be expanded to allow national and international networking and interdisciplinary development of strategies and projects.

##### **Need for research to create basis for standardised evaluation process**

The results of the REA project show that more research is needed in the area of evaluation and distribution of resource efficient technologies and products. Many challenges are identified during the project, based on difficult data availability in regards to resource consumption of technological innovations. This is especially the case for life-cycle wide data and details of

future development. The results point to obstacles in the evaluation of identified solutions due to limited data availability. Especially concerning the estimation of possible rebound effects it is important to note that resource efficiency is only one of many criteria in the scope of a sustainability assessment (Geibler and Rohn 2009). The formulating a standardized measurement internationally for the resource efficiency of technological innovations and products is even more of a challenge due to the number and diversity of different actors as well as the vast data and research necessary. For the research community, the need of action therefore is urgent in the development of an international standard to create uniform processes for evaluating potentials.

## References

- Aachener Stiftung Kathy Beys (ed.) (2006): Ressourcenproduktivität als Chance – ein langfristiges Konjunkturprogramm für Deutschland. Books on Demand GmbH, Norderstedt.
- BMU (Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit) (2012): Deutsches Ressourceneffizienzprogramm (ProgRess) - Programm zur nachhaltigen Nutzung und zum Schutz der natürlichen Ressourcen, Beschluss des Bundeskabinetts vom 29.2.2012. BMU, Berlin.
- BMU (Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit) (ed.) (2007): Umweltpolitische Innovations- und Wachstumsmärkte aus Sicht der Unternehmen, Forschungsprojekt durchgeführt von Roland Berger Strategy Consultants. BMU, Dessau.
- Bringezu, B.; van de Sand, I.; Schütz, H.; Bleischwitz, R.; Moll, S. (2009): Analysing global resource use of national and regional economies across various levels. In: Bringezu, B.; Bleischwitz, R. (eds). Sustainable resource management : global trends, visions and policies. Greenleaf, Sheffield. 10-51.
- Bundesministerium für Land- und Forstwirtschaft, Umwelt und Wasserwirtschaft (2012): Ressourceneffizienz Aktionsplan (REAP) Wegweiser zur Schonung natürlicher Ressourcen. Bundesministerium für Land- und Forstwirtschaft, Umwelt und Wasserwirtschaft, Vienna.
- Davies; Paton (2005): The Seawater Greenhouse in the United Arab Emirates: thermal modelling and evaluation of design options, Desalination 173, 2, 103–111.
- Deutscher Bundestag (2011): Enquete-Kommission Wachstum, Wohlstand, Lebensqualität. Available at: <http://www.bundestag.de/bundestag/ausschuesse17/gremien/enquete/wachstum/index.jsp>, last access 25 May 2012.
- Distelkamp, M.; Meyer, B.; Meyer, M. (2010): Quantitative und qualitative Analyse der ökonomischen Effekte einer forcierten Ressourceneffizienzstrategie. Ressourceneffizienzpaper 5.3; Wuppertal Institute for Climate, Environment and Energy, Wuppertal.
- EEA (Euroean Environmental Agency) (2011): Resource efficiency in Europe Policies and approaches in 31 EEA member and cooperating countries. EEA, Copenhagen.
- EU Parliament (2009): Eco-innovation - putting the EU on the path to a resource and energy efficient economy, available at



<http://www.europarl.europa.eu/document/activities/cont/201109/20110906ATT25985/20110906ATT25985EN.pdf>, last access 25 May 2012.

- Europäische Kommission (2011): Mitteilung der Kommission an das europäische Parlament, den Rat, den europäischen Wirtschafts- und Sozialausschuss und den Ausschuss der Regionen. Ressourcenschonendes Europa – eine Leitinitiative innerhalb der Strategie Europa 2020. Available at: [http://ec.europa.eu/resource-efficient-europe/pdf/resource-efficient\\_europe\\_de.pdf](http://ec.europa.eu/resource-efficient-europe/pdf/resource-efficient_europe_de.pdf), last access 25 May 2012.
- Geibler, J. v.; Rohn, H. (2009): Nachhaltigkeitsbewertung neuer Technologien als Fundament der Erschließung von nachhaltigen Zukunftsmärkten. Deutsches Cleantec Jahrbuch 2009. Deutsches CleanTech Institut, Bonn.
- Geibler, J.v.; Rohn, H.; Schnabel, F.; Meier, J.; Wiesen, K.; Ziemann, E.; Pastewski, N.; Lettenmeier, M. (2011): Resource efficiency atlas: An international perspective on technologies and products with resource efficiency potential. Wuppertal Institut, Trifolium, Fraunhofer Institut für Arbeitswissenschaft und Organisation (IAO), Universität Stuttgart, Institut für Arbeitswissenschaft und Technologiemanagement (IAT). Wuppertal Spezial 44e. Wuppertal Institute, Wuppertal.
- Global Footprint Network (2009): Annual Report. Global Footprint Network, Oakland.
- OECD (2009): Eco-Innovation in Industry – Enabling green Growth. OECD Innovation Strategy. OECD Publishing, Paris.
- OECD (2011): Better Policies to Support Eco-innovation. Studies on Environmental Innovation; OECD Publishing: Paris.
- Schmidt-Bleek, F. (2007): Nutzen wir die Erde richtig? Die Leistungen der Natur und die Arbeit des Menschen. Schriftreihe Forum für Verantwortung, Fischer-Verlag. Frankfurt am Main.
- Schütz, H.; Bringezu, S. (2008): Ressourcenverbrauch von Deutschland: aktuelle Kennzahlen und Begriffsbestimmungen Erstellung eines Glossars zum „Ressourcenbegriff“ und Berechnung von fehlenden Kennzahlen des Ressourcenverbrauchs für die weitere politische Analyse. Umweltbundesamt, Dessau-Roßlau.
- Sustainable Europe Research Institute (2011): Global resource use. Available from: [http://www.materialflows.net/images/stories/global\\_resource\\_use.zip](http://www.materialflows.net/images/stories/global_resource_use.zip), last access 25 May 2012.
- UNEP (2011): Towards a green economy. Pathways to Sustainable Development and Poverty Eradication. United Nations Environment Programme, Nairobi.

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Track 4c: Resource strategies: Industrial ecology, waste management, material cycles, and life cycle analysis

**Using causal maps to identify potential sources of environmental impact outside the scope of LCA studies: preliminary findings from case studies on washing machines and road vehicles**

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## Abstract

Much of the environmental impacts of which a product will potentially have during its life cycle are determined during the design phase by choices such as type of materials and manufacturing processes. The Life Cycle Assessment (LCA) method is commonly used to assess the potential environmental impacts and identify hot-spots for improvements of a product system. However, other important variables exist outside the product system that can also influence environmental impacts. The aim of this study is to utilise causal maps to identify variables which may not typically be identified and considered in LCA studies but may have significant influence upon environmental impacts through cause-effect chains. To illustrate the utility of causal maps, household washing machines and conventional passenger cars are chosen as case studies. Preliminary findings indicate that causal mapping can be used to identify which are the relevant variables and describe how they potentially interact in a system perspective. This knowledge might allow for more robust decision support.

## 1. Introduction

Environmental impacts can occur in different stages of a product/system service life cycle, including resource extraction, production, use, transport and end-of-life stages. Many of these impacts are introduced when design specifications of the product/system service are defined, such as in the material selection and manufacturing processes (Lewis and Gertsakis, 2001). Amid the design phase, several methods and tools can be applied in order to evaluate, from a life cycle perspective, the environmental performance of the product/system service. Life Cycle Assessment (LCA) is a 'cradle-to-grave' approach for assessing the potential environmental impacts of a product system over its full life cycle. Such a method allows for the identification of potential environmental impacts and hot-spots according to the design specifications to be made as well as for comparisons among different design alternatives and improvement options. These comparisons may aid in minimizing the identified impacts and to avoid shifting environmental impacts between different stakeholders and life cycle stages.

Limitations of the LCA method have been extensively discussed in the literature (Finnveden, 2000, Björklund, 2002, Udo de Haes et al., 2004). Reap et al. (2008a, 2008b) identifies the following issues as critical area of paramount importance: functional unit definition, boundary selection, allocation, spatial variation, local environmental uniqueness, data availability and quality.

LCA evaluates the environmental impacts of a product/system service in terms of a functional unit. The functional unit is defined as the “*quantified performance of a product system for use as a reference unit*” (ISO, 2006). This is commonly done to compare alternative ways of delivering the same function; this comparison is based on a unit common between all alternatives, which is termed the functional unit (Clift et al., 2000). Consequently, suggestions for optimization are traditionally made on the basis of a single unit, not taking into account the volume of units produced and the interrelations between these units and the surrounding system (e.g. how consumers are using other product/system services). This commonly used approach may hinder the possibilities of achieving higher levels of efficiency and reducing the negative environmental impacts in a predefined system of consumption and

production. Additionally, whilst these life cycle methods and tools can improve the environmental efficiency of product/system services, they do not go so far as to analyse the effectiveness of such services to fulfil societal needs.

The interpretation of LCA results are framed, *inter alia*, by the functional unit of a product/system service and the environmental effects identified (negative or positive) are associated with this function. However, products are not part of an isolated life cycle (i.e. cradle to grave). On the contrary, there are different levels of connections among the natural and technical environments, consumers, other products or services. For instance, how can a product be more efficient in different user concepts or how may consumption patterns affect resource availability in a regional or global perspective. These aspects need to be determined and assessed aligned with the evaluation of the functional unit in order to avoid that the “solutions” based on LCA results create further problems in other systems not taken into account by the LCA study.

The aim of this study is to utilise causal maps to identify variables which may not typically be identified and considered in LCA studies but may have significant influence upon environmental impacts through cause-effect chains. The purpose is to identify the different systems in which these variables are and their connections.

## **2. Methodology**

Household washing machines and conventional passenger cars (using gasoline or diesel) were chosen as case studies to illustrate the utility of causal maps. Literature surveys were then conducted for each case to identify the variables, system boundaries and functional units that are commonly adopted in LCA studies for washing machines and road vehicles. Subsequently, causal maps covering different domains – production, use, end of life, context/territory, and behaviour – were constructed during workshops, each consisting of experts in their respective field. During the workshops, experts were asked to brainstorm variables related with environmental impact of the function of the system and to discuss their connections. This process followed the Group-Model Building (Vennix, 1996), from the definition of the main variable to the result of these first workshops. Finally, a cross analysis of the results from the literature surveys and from the workshops was carried out.

### **2.1. Methods**

#### **2.1.1. Literature review**

A literature review was performed for the purposes of this paper in order to identify studies that investigate and evaluate the life cycle environmental impact of the two cases examined (i.e. road vehicles and washing machines). A number of scientific databases and library catalogues were examined using key words detailed in Table 1.

**Table 1 – Literature review key words**

<b>Road vehicles</b>	<b>Washing machines</b>
LCA, life cycle assessment	LCA, life cycle assessment
environmental impact	environmental impact
transport	washing machine

cars	household appliances
passenger cars	soap
road vehicles	detergent
life cycle assessment of passenger cars/road vehicles	clothes
	tissue

After the investigation 7-8 studies (the studies are cited in the Results section) for each case were selected and were in turn analysed based on the objectives of this paper. During the analysis of the identified studies the following aspects were identified:

- functional unit considered in the respective study
- system boundaries and life cycle stages examined
- environmental impact categories examined
- relevant variables considered and analysed in the studies

### **2.1.2. Causal mapping**

According to Vennix (1996), the process of assembling a model is a way of eliciting mental constructs, ideas about how things work in order to clarify and structure debate about a situation which is seen as problematic. A Causal Map (a type of model also known as inference diagram) represents how chosen variables/elements of a system interact with each other.

In a causal map, the interactions between the elements can be either reinforcing (positive) or balancing (negative). In a reinforcing relation both variables change in the same direction; that is, ‘the more one, the more the other one’ or ‘the less one, the less the other one’. Yet, in a balancing relation the variables change in the opposite direction; ‘the more one, the less the other one’ or ‘the less one, the more the other one’. The causal relationship between the two variables is represented by means of an arrow. The variable at the tail is supposed to have a causal effect on the variable at the point.

This graphical representation may assist in understanding the pattern of behaviour presented in a complex system and facilitates the communication among different stakeholders.

### **2.2. The workshops**

Two parallel workshops were organized to build the causal maps. The washing machine workshop was organized at the Polytechnic of Turin (Italy). Two Assistant Professors and three junior researchers (one PhD student and two research fellows) from the Department of Architecture and Design participated as industrial design experts. The workshop was facilitated by one of the authors with expertise in systemic design. The conventional passenger car workshop took place at the Royal Institute of Technology, KTH (Sweden). The expert participants were one PhD researcher from the Division of Environmental Strategies Research and four PhD students (with background on environmental economics, transport and location analysis, traffic and logistics, and LCA applied on transport infrastructures). The workshop was facilitated by two of the authors with expertise in LCA and System Dynamics.

The purpose of the workshops was to gain a first view of the:

- large system where the studied products are embedded

- variables that may influence the environmental performance of the product through cause-effect links within that system
- nature (positive or negative) of the relationships between these variables in order to get a better understanding of how the chosen variables may affect the environmental impact of the studied product through the cause-effect links

The aforementioned purpose was sent to the experts together with an explanation about the project in an invitation letter. The workshop lasted for a duration of approximately 2 hours.

The first step of the workshop was to introduce causal mapping to the participants. Examples of causal maps were shown and the procedure of building causal maps was explained. The starting variable (previously defined) of the causal map was ‘environmental impacts’ of cars/washing machines. In the second step the experts were asked to brainstorm the five most relevant variables they could think of, connected to the starting variable.

After the completion of this step, group members were invited in a round-robin fashion to name one variable (from their list) which was perceived as a potential cause of the starting variable. The variables were transferred to a white board. Then, the experts related these variables to each other. This procedure was repeated until all the perceived causes were placed in the causal map.

In the next step, the group was asked to consider the potential consequences (effects) of changing the main variable by looking at their list of variables. They were then placed into the map.

Finally, the experts were invited to look for connections between consequences and causes, i.e. consequences which in turn can be considered as causes of the ‘original’ causes. This led to the identification of potential feedback loops.

Not all of the variables were included directly in the map and new variables came up during the mapping process, which were not mentioned in the brainstorming phase.

### **2.2.1. Iterative Process**

It should be noted that the development of causal maps is an iterative process. It is necessary to repeat the process outlined above, building on previous versions of the causal maps in order to identify a greater number of variables, links and feedback loops, hence developing more complete and robust cause maps. The section below presents results from the first iteration of this process.

## **3. Preliminary Results**

### **3.1. Literature surveys**

The results of literature inventory are illustrated in Tables 2 and 3 representing the washing machine and road vehicles case studies respectively. The studies from where the data were extracted are cited below each table.

The pieces of information presented in the tables below provide a general overview of the analysed LCA studies. Similarities were observed with regard to the functional unit

considered in the different studies for the same case as well as when the life cycle stages and variables measured are concerned.

**Table 2 – Summary of the literature survey on washing machines: functional unit, life cycle stages and variables**

<b>Washing machines</b>			
<b>Functional unit</b>	<b>Life cycle stages</b>	<b>Variables</b>	
Amount of clothes (Kg) washed per year	Extraction of raw materials	Energy for production	Wash quality
	Transportation of raw material	Packaging	Type and amount of materials
	Assembling of components	Machine type	Energy for hot water
	Production of washing machine	Wash load (kg)	Energy for electricity
	Distribution (product to retailer)	Frequency of wash	Waste water treatment
	Use	Soap/softener	Waste treatment of detergent
	End of life (recycling)	Maintenance of washing machine	Waste treatment of packaging
		Program	

References: (Bourrier et al., 2011, Koerner et al., 2011, WRAP - Material Change for a better environment, 2011, Cullen and Allwood, 2009, Faberi et al., 2007, Dewaele et al., 2006, Rüdenauer et al., 2005, Collins and Aumonier, 2002)

**Table 3 – Summary of the literature survey on road vehicles: functional unit, life cycle stages and variables**

<b>Road vehicles</b>			
<b>Functional unit</b>	<b>Life cycle stages</b>	<b>Variables</b>	
One passenger car over its life time	Materials extraction an production	Average passenger cars in 5 among the 7 cases	Distance driven
	Assembly of parts and components		Life cycle energy needs (electricity and fuels)
	Production of vehicle	Weight and material composition of the vehicle (type and amount of materials)	Maintenance activities, washing
	Transportations		Recycling rates
	Use of the vehicle		Waste generation
Person Km travelled /Km travelled	Fuel cycle (Production of fuel / distribution / use)	Vehicle technology – fuel used (gasoline, diesel etc.)	Waste water treatment
	End of life management of the vehicle (dismantling, shredding, separation, recycling, reuse, waste disposal)	Fuel consumption (l/km)	
		Driving cycle	
		Life time of the vehicle	

References: (Schweimer and Levin, 2012, Nemry et al., 2008, Spielmann and Althaus, 2007, Finkbeiner and Hoffmann, 2006, Lane, 2006, Castro et al., 2003, Sullivan et al., 1998)

For the case of the road vehicles the majority of the studies included the stages of materials and vehicle production, use of the vehicle and end of life. The fuel cycle was not always

considered, apart from the process of fuel use which was integrated in the use phase of the car.

### **3.2. First version of causal maps**

Figures **Error! Reference source not found.** and **Error! Reference source not found.** present the outcome of the brainstorming section and a preliminary version of the causal maps for the two case studies. These maps illustrate the maps as developed by the experts with no further modifications from the authors. Whilst these maps will be further refined and developed through further iterations of group model building it is interesting to pause and highlight the differences and common elements among the cases, and also the life cycle approach.

The identified variables that the experts listed were divided in three main categories. The first one presents variables that are connected to the life cycle of the product and are grouped further in the production, use and end of life clusters. The second category includes variables related to the context or territory of the product, and are strictly dependent on its local characteristics e.g. the organization of the society, the infrastructure, the cultural and traditional identity. In addition variables connected to the behaviour of the user are also clustered in one category.

The maps also show the links and relationships among the variables, the nature of these relationships (positive or negative). The variables which were not found in the LCA studies are stressed in bold text.





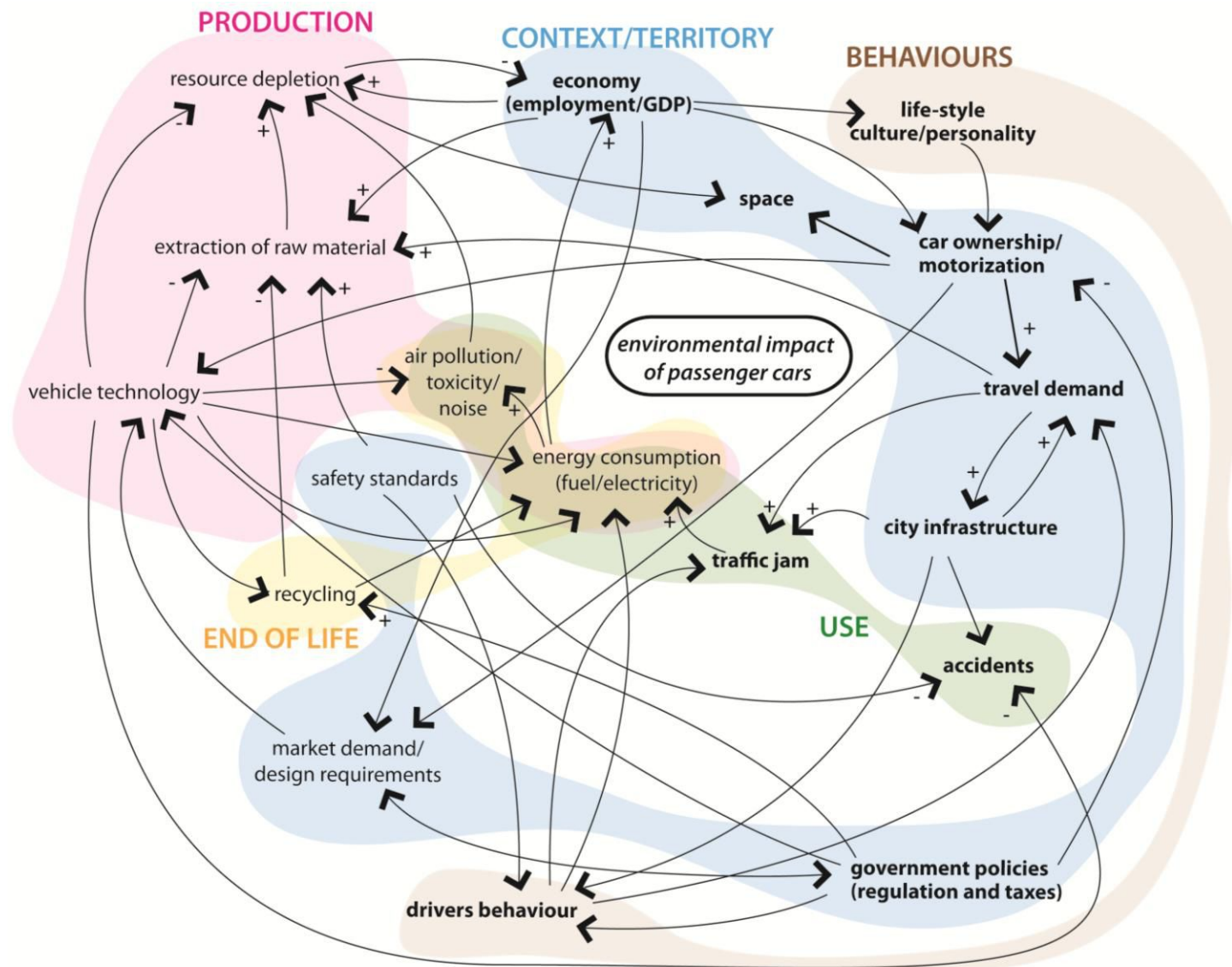


Figure 3 – Variables related with environmental impacts of cars grouped in categories and their cause-effect links; the bold text underlines variables not included in LCA studies

#### **4. Analysis - comparison of the LCA studies and the causal maps**

The approaches literature survey and the causal mapping identified a number of variables that may influence the environmental performance of the studied products. The functional units commonly used in the two case studies are dependent on the variables identified in both the LCA studies and (almost all) causal mapping. In other words, almost all the variables identified using these two different approaches can influence the functional unit. This influence can be direct connected or (indirect) connected by means of feedback loops.

For instance, in the case study on road vehicles, the environmental impact per passenger car over its life time or per km travelled (based on the functional units that are usually considered) can be influenced by ‘energy consumption’ (a variable identified in the LCA studies). The more the ‘energy consumption’, the more the ‘employment/GDP (economy)’ (a variable included in the causal map). ‘Employment/GDP (economy)’ influences ‘car ownership / motorization’. The more the ‘car ownership / motorization’, the more the ‘travel demand’. The more the ‘travel demand’, the more the ‘traffic jam’. ‘Traffic jam’ in turn affects the ‘energy consumption’. This is an example of feedback loop between connected variables identified in both studies whose can influence the functional unit.

In contrast, in the case study on washing machine, the influence which the variables listed in the causal map is more direct. The ‘amount of clothes washed per year’ are, for example, directed connected with the ‘cultural identity’ (a variable not commonly used in LCA studies). ‘Cultural identity’ may refer, for instance, to cultural traditions of washing clothes often/seldom. This is directed connected with the number of washing cycles per year and consequently with the lifespan of a washing machine.

Although the variables identified by both approaches are very similar in terms of concept, it can be observed that the LCA studies focused more on quantitative variables (weight of the product, amount of materials or energy use etc) while during the creation of the causal maps a number of “soft” or qualitative variables were identified. Such variables assist in structuring and identifying the system that the studied products are part of, but may also serve as additional areas where environmental impacts may occur.

The backgrounds of the experts in the two parallel sessions were different, however, during both workshops the necessity of including more qualitative data to the LCA approach was pointed out. Especially regarding the case of the washing machine, where experts participating in the workshop were not so familiar with the LCA methodology. For instance, semantic, technological (relating to the function of the washing machine) and technical (relating to the components of the washing machine) obsolescence were identified in the washing machine workshop as qualitative factors. However, these elements are indirectly included in an LCA of a washing machine; they are included in the assumptions associated with the life-time of the washing machine which is done in order to distribute the environmental impacts of producing the washing machine over the functional unit.

Moreover, the experts stressed how the users’ behaviour is strictly dependent to the characterization of the context where they live in. In both workshops the experts highlighted

that the variables in the context/territory category play an important role in influencing the environmental impacts.

According to the systemic approach, in fact, the territory with its specificities influences the behaviour of the inhabitants. Because of that, the “factor of locality” should be taken into consideration during the design of a product, or a service, and also in the calculation of its environmental impact (Bistagnino, 2011). This may, for example, include such factors as choice of wash temperature, the importance of having a full washing machine before it is used, etc. These factors may also be related to socio-economic factors and cultural aspects such as how ‘clean’ is defined.

During the workshop, the experts suggested the possibility of including a sort of “parameter of locality”, different for every territory, through which the quantitative data from the LCA should be critically used in different contexts. It is interesting that, even though the backgrounds of the experts in the two parallel sessions were different, both workshops expressed the necessity of including more qualitative data to the LCA approach.

Both causal maps show a partial overlapping of different domains, i.e., variables that were classified in more than one domain; the comparison of this fact with the previously literature review shows the linearity of the LCA approach, probably due to the necessity of the LCA of defining measurable data usable in different studies.

Despite the both maps show the same domains, variables are often different; this fact is probably due to the non-homogeneous background of the experts, which was the key element for making multidisciplinary workshops. Probably for this reason, experts for the washing machines’ map which work in the design field, were particularly focused on the environmental impact caused by the product itself e.g. *shape of the product* and by the relationships that the product has with the other products in the house e.g. *links with the other appliances*; while variables pointed out during the vehicles’ workshop are more related to a general level e.g. *traffic jam* or *city infrastructure*, and do not consider the possibility of re-building the vehicle in a different way.

## **5. Discussion**

### **5.1. Building causal maps**

One of the beneficial effects of causal mapping is that transformed tacit knowledge in explicit knowledge and put it in a systemic perspective. It thus revealed important relationships between various elements that influence the environmental impact of washing machines and passenger vehicles. During the implementation process and building of the causal maps a number of limitations or difficulties were identified. Experts participating in the workshops were not familiar with +/- signs and they thought the signs were too much constraining. For further development of the causal maps, authors should endeavour to find an easier way to characterize causes and consequences in the map, in order to preserve the “systemic character” of the workshop.

The duration of the workshop proved to be a factor limiting the both the drawing of the maps, discussing all the links among the factors, identifying feedback loops and also for thinking

about the specific role of each element in the map. In subsequent workshops experts will have more time for discussing their opinions and defining their terminology.

Despite the different backgrounds of the experts, it is interesting to notice that both of the workshops underlined two main issues. The former is the necessity of including qualitative aspects in the analysis of the environmental impact of products, and the latter is the relevance of the context as factor of influence of several parameters, such as human's behaviour, cultural identity of the product, city's infrastructures and policies.

The causal maps can produce new, fresh and valuable strategic insights in a system perspective. These insights can change the perception of the LCA results and be combined with them to ultimately take purposeful actions to improve a problematic situation. The differences between the results of the LCA studies and the causal maps can stimulate the debate about the process of change and responsible decision making.

## **5.2. Next steps**

Two opportunities for further research are seen. The first one concerns the common use of causal mapping and LCA, secondly, the development of quantitative system dynamics modelling.

### **5.2.1. Common use of causal mapping and LCA**

Regarding this common use, a first proposal is to develop a causal map to build a meta understanding (big-picture) of a situation seen as problematic before undertaking a LCA study. This approach may give a view of where the variables considered in the LCA stand in relation to the variables considered in the causal map.

A second idea regarding the common use of causal mapping and LCA is to define parameters related to the territorial factor to the LCA. These parameters could be used as factor of correction for the quantitative data that come from the LCA. This would allow fitting and characterizing the study in the particularities of different territories. From this point of view, the function of the "corrective" parameters (that can be called "parameter of locality") could influence the data from the LCA, giving to them a different value in term of the environmental impact, according to the characteristics of the territory in which the product is located.

### **5.2.2. Quantitative system dynamics modelling**

Quantitative system dynamics modelling can reveal not only variables, causal links and their polarity, but also delays as well as feedback loops. Soft variables like human behaviour and life-style can be quantified (see Sterman (2000)). The models could then be simulated on a computer to look for nonlinearities relations underlining the system behaviour. Quantitative system dynamics modelling and simulation offer a full understanding of the behaviour of systems.

## 6. Conclusion

This study underlined that variables normally included in LCA studies and variables usually not included can influence each other through cause-effect relations. These interactions affect the overall environmental impact of a product. Therefore, they need to be considered when solutions are proposed. Our preliminary findings show that the variables usually not included in LCA studies tend to be more soft variables, dependent for instance with human behaviour and context / territory.

Causal mapping can be used to identify which are those relevant variables and to describe how they potentially interact. This knowledge might improve the quality of the decision based on the LCA studies.

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## References

- BISTAGNINO, L. (ed.) 2011. *Systemic Design: Designing the productive and environmental sustainability*, Bra: Slow Food editore.
- BJÖRKLUND, A. 2002. Survey of approaches to improve reliability in LCA. *The International Journal of Life Cycle Assessment*, 7, 64-72.
- BOURRIER, C., CORSINI, F., DANTHUREBANDARA, M., FUCHS, K., OLLOZ, S., POULIKIDOU, S., RUFENER, S. & SINGH, R. 2011. Washing Machine. ETH Sustainability Summer School 2011. Zurich: ETH Zürich - Eidgenössische Technische Hochschule Zürich.
- CASTRO, M., REMMERSWAAL, J. & REUTER, M. 2003. Life cycle impact assessment of the average passenger vehicle in the Netherlands. *The International Journal of Life Cycle Assessment*, 8, 297-304.
- CLIFT, R., DOIG, A. & FINNVEDEN, G. 2000. The Application of Life Cycle Assessment to Integrated Solid Waste Management Part 1—Methodology. *Process Safety and Environmental Protection*, 78, 279-287.
- COLLINS, M. & AUMONIER, S. 2002. Streamlined Life Cycle Assessment of Two Marks & Spencer plc. Apparel Products. Oxford: Environmental Resources Management
- CULLEN, J. M. & ALLWOOD, J. M. 2009. The role of washing machines in life cycle assessment studies. *Journal of Industrial Ecology*, 13, 27-37.
- DE HAES, H. A. U., HEIJUNGS, R., SUH, S. & HUPPES, G. 2004. Three Strategies to Overcome the Limitations of Life-Cycle Assessment. *Journal of Industrial Ecology*, 8, 19-19.
- DEWAELE, J., PANT, R. & SCHOWANEK, D. 2006. Comparative Life Cycle Assessment (LCA) of Ariel "Active à froid" (2006), a laundry detergent that allows to wash at colder wash temperatures, with previous Ariel laundry detergents (1998, 2001). *Comparing the environmental burdens of home laundry detergent products and*



- laundry habits in France 1998-2006*. Brussels: Procter & Gamble, Brussels Innovation Center, Central Product Safety -Environmental.
- FABERI, S., PRESUTTO, M., STAMMINGER, R., SCIALDONI, R., CUTAIA, L., MEBANE, W. & ESPOSITO, R. 2007. Preparatory Studies for Eco-Design Requirements of EuPs. Domestic Washing Machines & Dishwashers. ISIS.
- FINKBEINER, M. & HOFFMANN, R. 2006. Application of Life Cycle Assessment for the Environmental Certificate of the Mercedes-Benz S-Class (7 pp). *The International Journal of Life Cycle Assessment*, 11, 240-246.
- FINNVEDEN, G. 2000. On the Limitations of Life Cycle Assessment and Environmental Systems Analysis Tools in General. *The International Journal of Life Cycle Assessment*, 5, 229 - 238.
- ISO 2006. Environmental Management - Life cycle assessment - Requirements and guidelines (ISO 14044:2006).
- KOERNER, M., SCHULZ, M., POWELL, S. & ERCOLANI, M. 2011. The Life Cycle Assessment of Clothes Washing Options for City West Water's Residential Customer. *ALCAS Australian Life Cycle Assessment Society, Conference*. Melbourne, Australia.
- LANE, B. 2006. Life Cycle Assessment of Vehicle Fuels and Technologies. Ecolane Transport Consultancy.
- LEWIS, H., & GERTSAKIS, J. 2001. *Design + Environment: A global guide to designing greener goods*. UK: Greenleaf Publishing Limited.
- NEMRY, F. and LEDUC, G. and MONGELLI, I. and UIHLEIN, A. 2008. Environmental Improvement of Passenger cars (IMPRO-car). JRC-European Commission.
- REAP, J., ROMAN, F., DUNCAN, S. & BRAS, B. 2008a. A survey of unresolved problems in life cycle assessment. *The International Journal of Life Cycle Assessment*, 13, 290-300.
- REAP, J., ROMAN, F., DUNCAN, S. & BRAS, B. 2008b. A survey of unresolved problems in life cycle assessment. *The International Journal of Life Cycle Assessment*, 13, 374-388.
- RÜDENAUER, I., GENSCHE, C. & QUACK, D. 2005. Eco-Efficiency Analysis of Washing Machines: Life Cycle Assessment and determination of optimal life span. Freiburg: Öko-Institut e.V. Institute for Applied Ecology.
- SCHWEIMER, G. W. & LEVIN, M. Life Cycle Inventory for the Golf A4. Available from: [www.volkswagen.-environment.de](http://www.volkswagen.-environment.de). March 2012.
- SPIELMANN, M. & ALTHAUS, H.-J. 2007. Can a prolonged use of a passenger car reduce environmental burdens? Life Cycle analysis of Swiss passenger cars. *Journal of Cleaner Production*, 15, 1122-1134.
- STERMAN, J. 2000. *Business dynamics: Systems Thinking and Modeling for a Complex World*, Irwin McGraw-Hill.
- SULLIVAN, J.L., WILLIAMS, R.L., YESTER, S., COBAS-FLORES, E., CHUBBS, S.T., HENTGES, S.G., POMPER, S.D. & SOCIETY OF AUTOMOTIVE ENGINEERS. 1998. Life Cycle Inventory of a Generic US Family Sedan: Overview of Results USCAR AMP Project. *Total Life Cycle Conference & Exposition, November 1998*. SAE Technical Paper 982160, doi:10.4271/982160.

- VENNIX, J. A. M. 1996. *Group model building: Facilitating team learning using system dynamics*, John Wiley & Sons.
- WRAP - MATERIAL CHANGE FOR A BETTER ENVIRONMENT 2011. Environmental life cycle assessment (LCA) study of replacement and refurbishment options for household washing machines. WRAP - Material Change for a better environment.



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**Towards a framework of life cycle sustainability assessment (LCSA)**

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**Abstract**

Companies make business decisions that affect people and the environment, directly through their own operations or indirectly through their product chain. As stakeholders understanding of the impact of these decisions improves, the business sector will be increasingly challenged to address the issue of sustainability, considering economic, environmental and social factors when making decisions. It is not clear, however, whether the frameworks businesses use enable them to consider sustainability effectively.

The development of a framework for integrated assessment of the three pillars of sustainability could help companies make better sustainability decisions. Life cycle tools help broaden the system boundaries considered by an actor and converts inputs and outputs into impacts and so could be a useful tool for helping companies understand the impact of their operation. Individual methodologies exist for environmental, economic and social life cycle tools, but there is no life cycle sustainability assessment currently.

In the absence of a complete integrated framework, this paper evaluates the literature regarding the integration of life cycle tool results. Current approaches in the literature are identified and evaluated and the findings discussed.

It was found that there is no fixed method for integrating multiple life cycle perspectives. Furthermore some of the drawbacks of the individual life cycle tools (e.g. subjectivity of evaluation in the case of single-dimension comparisons, complexity in presentation of results in the case of multi-dimensional comparisons) are reinforced and even magnified when attempting to evaluate multiple life cycle perspectives. A clear understanding of these issues is required in order to develop an effective life cycle sustainability assessment.

# 1 Introduction

The problem that we are addressing is the integration of the economic, environmental and social aspects of the life cycle of firms' activities. Companies make business decisions that affect people and the environment, directly through their own operations or indirectly through their product chain. These impacts challenge the business sector to address the issue of sustainability. This challenge requires firms to enact well-planned strategies at the organization level that are aligned with performance at the operational level.

Although more and more companies claim activity towards sustainability at the strategic and operational levels, it appears that the frameworks used to support these activities do not adequately account for environmental and social issues. There is a need for sustainability evaluation processes to be included as a part of normal business processes (Labuschagne and Brent, 2005); this evaluation process should map the product chain and address problems that relate to the three pillars of sustainability.

Lifecycle tools individually accomplish the criterion of mapping the product chain, but they need to integrate the three lifecycle perspectives to help understand the problems that are related to the three dimensions. The integrated analysis of their results will be very useful for sustainability-informed decision making.

This paper will therefore evaluate the current state of lifecycle tools and attempts at integration as foundation for moving towards a life cycle sustainability assessment (LCSA).

## 1.1 Life cycle tools

In this paper, when lifecycle tools are discussed it refers to Environmental Life Cycle Assessment (ELCA), Life Cycle Costing (LCC) and Social Life Cycle Assessment (SLCA). ELCA is traditionally used to assess the environmental impacts of a product from cradle to grave and inform about environmental impacts; ISO 14040 (2006); describes the ELCA framework. LCC is the economic complement of ELCA; it is used to assess internal and external costs associated with products lifecycle and is associated to the actors involved in the product's lifecycle (Hunkeler et al., 2008). SLCA is a tool that is still in its early stages; its goal is the assessment of social impacts along the lifecycle (Benoit et al., 2009).

The two most important strengths of life cycle tools are:

1. Application of the lifecycle perspective, this approach is broadening the system boundaries to product lifecycle and not on a specific site compared to the rest of the tools (Azapagic and Clift, 1999; Finnveden, 2000). This advantage allows:
  - The assessment of potential improvements by modeling the product lifecycle or specific process (Azapagic and Clift, 1999).
  - The modeling of product lifecycle could help identify areas of improvement of product systems (Finnveden and Ekvall, 1998) through multi-objective optimization (i.e. add technical, economic, social, design, operational features) (Finnveden, 2000).
  - Product comparisons (Azapagic and Clift, 1999).

2. They have the ability to translate inputs and outputs to impacts (Azapagic and Clift, 1999; Finnveden, 2000); which allows improvement actions to be prioritized and planned (Finnveden and Ekvall, 1998).

Before considering the integration of tools it is necessary to highlight the weaknesses of lifecycle tools. The reported disadvantages of lifecycle tools include:

- Not all relevant impacts/costs are considered (Owens, 1997; Finnveden, 2000).
- The databases available to conduct LCA analyses have uncertainties and not representative (Finnveden and Lindfors, 1998; Huijbregts et al., 2001). There are dissimilarities among different databases (Owens, 1997; Rebitzer et al., 2003). Also, data is collected at an organizational level and not at a functional level, this makes it difficult to separate individual processes (Rebitzer et al., 2003).
- Weighting of social and environmental impacts contains ideological and ethical values which cannot be objectively determined, since there is no way by which the 'true' values can be evaluated. Results which rely on weighting can always be challenged by other stakeholders (Finnveden, 2000). Significant model differences in the impact assessment stage have been identified (Rebitzer et al., 2003). There are differences in how various modeling approaches generate indicators because of subjective judgment (Owens, 1997).
- Not taking into account for the changes over time of flows, impacts, costs (Owens, 1997; Stasinopoulos et al., 2011).
- During the inventory analyses there is fear of double counting or exclude flows (Cullen and Allwood, 2005).
- The impacts of each action in the product chain are not the same in different areas and lifecycle tools are not considering the background environmental, social and economy level of the area. (Finnveden et al., 2009).
- Can show potential benefits, but not the rebound effects. (Thabrew and Ries, 2009).

Each of the lifecycle tools is designed to address a different question and each of the three tools comes up with information about a different aspect of the same process, each with their own strengths and weaknesses. The relations between the tools are not well established and deserve a thorough and critical discussion (Klopffer and Heinrich, 2002). These diverse lifecycle views are important for helping firms become more sustainable. Therefore there is a need for a tool which considers all three aspects together in some way. The alignment of these frameworks within the principles of sustainable development should provide a clear understanding of the various life cycles involved and their interrelations (Labuschagne and Brent, 2005).

## 1.2 Integration

The lifecycle tools mentioned above are three separate tools that help decision making separately. But, the concept of sustainability implies the parallel consideration of the three pillars (i.e. environmental,

economic and social) (Dyllick and Hockerts, 2002). ELCA, LCC & SLCA represent the lifecycle perspective of each pillar and their integration under a common framework could create a sustainable framework with lifecycle perspective (SETAC, 2011). At the moment LCSA is the only tool that could provide this view of the system.

According to SETAC (2011) the benefits of LCSA are:

- raise awareness among current and future decision makers in making better sustainability informed decisions.
- assist stakeholders seeking to make holistic assessments of product lifecycle sustainability,
- support enterprises and people who are trying to reduce environmental degradation, prevent negative social impacts and increase social and economic benefits during the life cycle of a product.
- allow practitioners to organize complex environmental, economic and social information and data in a structured form.
- help in clarifying the trade-offs between the sustainability pillars, lifecycle stages and impacts, products and generations by providing a more complete picture of impacts along the product lifecycle.
- guide enterprises on how to become more responsible by taking into account the full range of impacts associated with their products and services.
- promote awareness in value chain actors on sustainability issues.
- support enterprises and value chain actors in identifying weaknesses and opportunities for improvements of a product with a lifecycle perspective.
- assist decision-makers in prioritizing resources and investing them where there are more chances of positive impacts and less chance of negative ones.

The integration of lifecycle tools is a potentially useful contribution to sustainability practice. The action of integration however faces a number of theoretical and practical challenges relating to differences between normal applications of the tools. O'Brien et al. (1996) and Norris (2001) described the different purpose and approach of social and economic issues respectively with environmental issues. The main differences of the tools are described in Table 1. LCAS is a tool which aims to support decision making by including three different types of analysis as part of the same 'equation'. To accomplish that effectively there is a need to apply the tools concurrently in the same context.

Table 1. How ELCA, LCC & SLCA differ. Derived from O'Brien et al., 1996; Norris, 2001; Benoit et al., 2009.

	ELCA	LCC	SLCA
Purpose	Measure environmental performance	Identify cost- effectiveness of investments	Measure social performance
Flows	Pollutants, resources, energy	Costs	Working hours, working accidents, local employment, fair competition, CSR, corruption, supplier relationships, etc.
Units	Physical units	Monetary units	Social units
Nature of data	Derived by researchers using primary and secondary data	Financial are provided by operators, environmental and social related are derived by researchers using primary and secondary data	Derived by researchers using primary and secondary data
Time perspective	Not critical, usually 100 years' time horizon.	Very critical, the value of costing units is continually changing	Not critical, usually 1,5, 10 years horizon; impact dependent
System boundaries	Raw materials to EOL	Product R&D to EOL	Raw materials to EOL

### 1.3 Efforts to integrate

Researchers have already tried to integrate two of the abovementioned life cycle tools. Norris (2001) is among the first researchers that mention the integration of LCC and ELCA whilst Reich (2005) combined LCC and ELCA in municipal waste management case studies. Also, O'Brien et al. (1996), Weidema (2005) and Greißhammer et al. (2006) discuss the integration of ELCA and SLCA. In addition, Klopffer (2003 & 2005), Pflieger et al. (2005) and Guinee et al. (2011) mentioned the integration of all three life cycle tools, but do not provide any detail on how the integration will be achieved.

Klopffer (2008) put this idea of creating a Lifecycle Sustainability Assessment (LCSA) framework into context when he suggested the combination of the three techniques. Klopffer also mentioned the importance of incorporating the results of each tool with the results of the other tools; this will allow for integrated decision-making based on a life cycle perspective and the consideration of the three sustainability dimensions.

### 1.4 Novelty of research

Over the course of the last decade frameworks and case studies on integration of lifecycle tools have been published, but their approach to integration often differs. This variation in the approaches to integration is the trigger for this research as better understanding current approaches to integration may support the development of a framework for LCSA. The aim therefore is to analyze the papers that are addressing the integration of at least two of the lifecycle tools and identify and evaluate the integration approaches.

## 2 Methodology

This objective of this study is the analysis of the academic literature that is focused on the integration of at least two of the following tools Environmental Life Cycle Assessment (ELCA), Life Cycle Costing (LCC) and Social Life Cycle Assessment (SLCA).

### 2.1 Source of info

The data was collected from articles in the scientific literature. The search terms used focused on “integration” and included the combination of the life-cycle tools, i.e. ELCA and SLCA or LCC. Candidate papers were selected by the author if they in some way addressed multiple life cycle views and how these views might be brought together and evaluated in practice. Papers were also identified by the snowballing method – references cited by search identified papers were investigated and included or excluded in the study using the same criteria.

### 2.2 Selection criteria

The main criterion for an academic paper to be considered for this study was that the paper is addressing the integration of at least two of the lifecycle tools (i.e. ELCA, LCC and SLCA) by conducting multiple lifecycle evaluations concurrently, by proposing an integration framework or by conducting an integration case study.

### 2.3 Papers analysis strategy

The analysis of the papers that entered the study was conducted through the following steps:

- Type of attempted integration:
  - Integration of ELCA & LCC.
  - Integration of ELCA & SLCA.
  - Integration of ELCA, LCC & SLCA.
- Focus of the study:
  - Development of a theoretical integration framework.
  - Case studies of integration.
- Identify patterns of integration:
  - Assessment.
  - Synthesis of results.

### 2.4 Limitations

Although much time was spent searching for papers, the search strategy for papers was not exhaustive or systematically organized. Relevant papers or sections of the literature may therefore have been missed. Furthermore, not all relevant reports were accessible at the time of writing. The review of the

literature includes examples from practice, but there has been no direct contact with practice to identify challenges in implementation or examples of integration efforts by companies outside of the literature.

### 3 Data Collected

Table 2 contains the papers that were found in research and which passed the criteria for consideration in this study. The papers are categorized according to the tools that were considered for integration.

Table 2. Papers selected for analysis.

ELCA + LCC		ELCA + SLCA		LCSA = ELCA + LCC + SLCA	
1	Guinée et al., 2006.	7	O'Brien et al., 1996.	13	Schmidt et al., 2004.
2	Corti et al., 2009.	8	Gauthier, 2005.	14	Buchholz et al., 2008
3	Lyrstedt, 2005.	9	Labuschagne et al., 2005.	15	Finkbeiner et al., 2010.
4	Sundin et al., 2011.	10	Franze and Ciroth, 2011.	16	Peri et al., 2011.
5	Yamaguchi et al., 2007.	11	Franze and Ciroth, 2011.	17	Vinyes et al., 2011.
6	Reich, 2005.	12	Weidema, 2006.	18	Capitano et al., 2011.

### 4 Analysis

By comparing the approaches of the selected, it appears that there a number of distinct approaches to the integration of life cycle results. Some studies conduct concurrent LC perspectives but do not attempt to integrate the evaluation of the results and discuss the results separately. Those that have attempted integrations have appeared to follow one of two paths, which are outlined in Figure 1. The first approach is the Multi-dimensional approach where each impact / cost identified by the individual life cycle tool is considered in parallel with the individual results of the other life cycle tool/s under consideration. This path keeps each impact / cost separate and retains their original units (i.e. Kg of CO<sub>2</sub>, \$ & accidents) in most of the cases. In the remaining cases the results are analyzed further, by translating them into a common unit, so that results may be compared on an equal footing.

The second approach is the Single-dimension approach; this approach gradually integrates the results of each lifecycle tool by combining the results from a single life cycle tool into a single measure and then combining these measures into a single result for a given sustainability pillar. These results are then integrated into one number (direct integration) or arranged into representation, which describes the “sustainability” balance of the situation under consideration (describe balance).

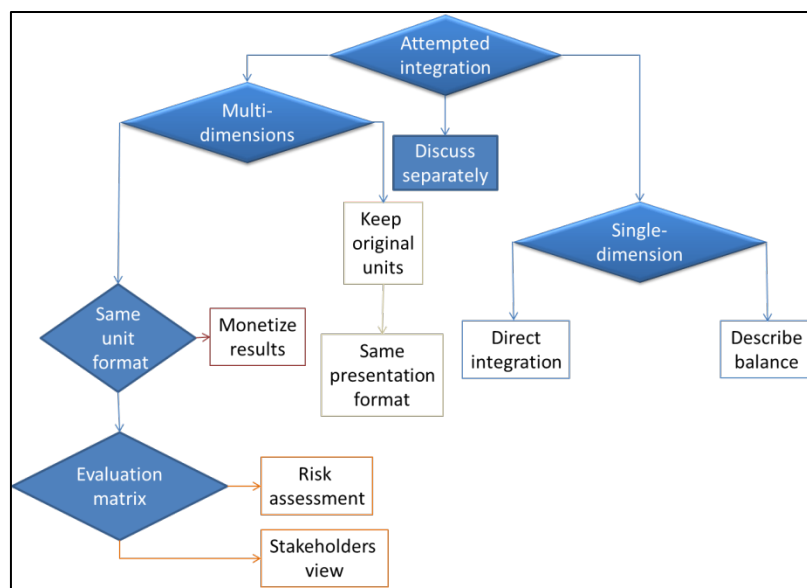


Figure 1. Integration paths.

The papers are separated in three categories according to the type of assessment; of the 18 papers, 5 did not try to integrate the lifecycle tools results, whilst 8 are classified as Multi-dimensional and 5 as Single-dimension. The papers assessed are categorized further according to subsequent treatment. Table 3 describes the allocation of papers according to their categorization. From the analysis in Table 3, it seems four out of eighteen papers maintained the original units and retained Multi-dimensional nature of the original analyses. Five papers stopped their analysis when they finished the separate lifecycle analyses; this shows that most of these papers mentioned the integration of lifecycle tools, but they did not attempt it. After this clearance, it seems that eight papers used the Multi-dimension path and five followed the Single-dimension path. Also, it seems that although SLCA is not an established framework yet, there are cases of integration with the other tools.

Table 3. Papers analysis categorization.

	Multi-dimensional			Discuss separately	Single-dimension	
	Same presentation format	Evaluation matrix	Separate monetization		Direct integration	Describe balance
ELCA + LCC papers	1, 2	-	5,6	-	3, 4	-
ELCA + SLCA papers	7, 8	9	-	10, 11	12	-
LCSA papers	-	14	-	16, 17, 18	13	15



## 4.1 Integration strategies

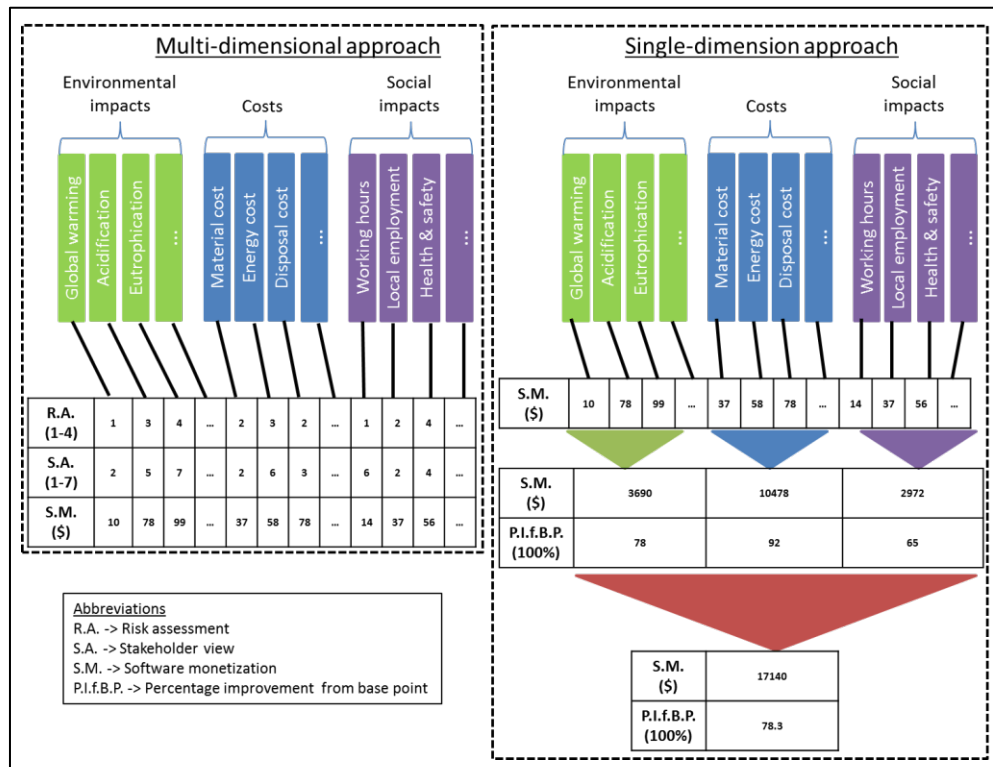


Figure 2. Multi-dimension and Single-dimension approaches.

In the literature the way that ELCA, SLCA and LCC have been attempted to be integrated varies according to the two paths described in Figure 1. Multi-dimensionality is an approach that assesses the impacts identified in each life cycle tool simultaneously. Single-dimension is an approach that integrates the results of lifecycle tools into combined scores. Both approaches are described in Figure 2 and the following sections will describe the detail of these approaches and the subsequent processing and presentation options found in the literature.

### 4.1.1 Multi-dimensionality

The main characteristic of this approach is that the results are not aggregated or combined together in any way. This retains the richness of the original analysis, allows the identification of specific areas of concern e.g. hotspots, which could help in the decision making process. The parallel analyses of different impacts allow the user to explore the interrelations between pillars of sustainability. As described in Figure 1, the Multi-dimensional approaches were found that have four interconnection approaches, three of which involve converting each individual impact category into a common unit.

#### ***4.1.1.1 Same presentation format***

Using the same format to present the results of each lifecycle tool is a common practice among the papers that use the multi-dimensional approach. This level of analysis places the results of the tools together in the same format (i.e graph or table) for comparison and to try to identify interrelations, if any.

Guinee et al. (2006) presented two different waste water treatment processes assessing them in environmental and economic terms. From the results presented, it seems that one process is the most preferable because it costs less and has less environmental impacts. However, the aforementioned process has larger eutrophication impact; if eutrophication was a key indicator, and this impact was sufficiently detrimental, it could affect the decision.

Cort et al. (2009) assessed packaging options with a cradle to grave approach. The analysis of results was similar Guinee et al. (2006), but they used tables instead of graphs to communicate the results. O'Brien et al. (1996) tried to explore how the results of ELCA will affect the social impacts and how the results of SLCA will affect the environmental impacts. Gauthier et al. (2005) provides a table where all the important environmental and social issues are mentioned for each lifecycle stage from cradle to grave for a mobile phone charger.

#### ***4.1.1.2 Separate monetization***

The second multi-dimensional path is the monetization of the lifecycle tools results where each result of each lifecycle tool is translated to a monetized unit by software. This approach was used by Yamaguchi et al. (2007) and helped them to monetize the environmental impacts of the lifecycle of a washing machine and make them comparable with the results of LCC. Reich (2005) had a similar approach; 8 waste management options are assessed by comparing the results of an LCC exercise and monetized ELCA the ELCA results.

#### ***4.1.1.3 Evaluation matrices***

The third multi-dimensional method is the use of evaluation matrices. In these matrices the relative importance of the different impacts are evaluated. As seen in Figure 2, risk assessment is used to evaluate the risk and severity of an occurrence for different types of impacts and identify hotspots; this was the case for Labuschagne and Brent (2005). Another approach is used from Buchholz et al., (2008); in this case key stakeholders are interviewed and asked their opinions on the importance of some key environmental, social and economic criteria. This is then used to weight the results and support prioritization and hotspot identification. Among the multi-dimensional papers these two papers use this approach. This maybe because they use only lifecycle process approach and they don't use lifecycle tools; they use impact & risk assessment methods for each lifecycle stage.

#### 4.1.2 Single-dimension

The Single-dimension approach builds on the results of the separate monetization (or harmonization) of the Multi-dimension approach. The single-dimension approach takes the each category (e.g. GHG emissions, Eutrophication) within a given sustainability pillar and converts these into a single consistent dimension (e.g. \$). These category results are then combined to provide a summary figure for a given sustainability pillar (e.g. The Environmental). The single-dimension results of each pillar are then combined together to form the single-dimension sustainability “score”.

##### 4.1.2.1 Direct integration

Direct integration is the approach where the separate results of the lifecycles tools are monetized and combined ending up as a single-number that characterizes their value. (e.g. Environment = \$3,690). These results are then combined with the equivalent results from the other sustainability pillars to give a summary sustainability value (e.g. Sustainability = \$17140). Lyrstedt (2005) used the Environmental Damage Cost (EDC) monetization method to express environmental impacts in costing terms. In this way environmental impacts are directly intergrated with LCC results. Schmidt et al. (2004) use a similar approach, but they integrated LCC, ELCA & SLCA results.

Weidema (2006) proposed a harmonization method that integrates environmental and social aspects to measure human well-being through a new measurement type the Quality Adjusted Life Years (QALY).

Sundin et al. (2011) tried to identify the lifecycle environmental and economic benefits of Product Service Systems (PSS) compared to traditional business approaches. The researchers’ monetization approach was not the classical one. They set the traditional business model as a base (set as 100%) and they compared the performance of the other business approaches with the base for both ELCA and LCC results. For each case it seems that the mean environmental percentage change is presented, but this could hide the variations of the different environmental impacts; like the case with eutrophication described in the same presentation format in section 4.1.1.1. An example of this is given in Figure 2 named as the Percentage improvement from base point (P.I.f.B.P.).

##### 4.1.2.2 Describe the balance

The last category is the use of the results to describe the balance among environmental, economic and social aspects by representing the weighting of each pillar in a specific format. Finkbeiner et al. (2010) described this method. It is related to a triangle framework where their angles represent one of the sustainability pillars. The results of each pillar results are reduced to a single-number and expressed as a percentage of the following expression  $\frac{\text{pillar single number}}{\text{sum of 3 pillars numbers}}$ . The sum of the three factors is 100 and is represented with a point in the triangle, similar to the one in Figure 3.

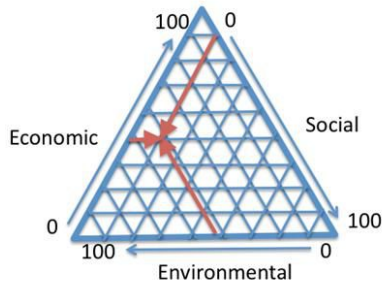


Figure 3. Describe the balance results presentation

## 5 Discussion

### 5.1 Multi-dimensional vs. Single-dimension approach

The analysis section identified two approaches to the integration of separate life cycle result sets, one in which the impact categories are kept separate and visible during the analysis (multi-dimensional analysis) and one in which the results for different impact categories are converted into common units and combined (single dimension analysis). Both analyses contain elements of subjectivity, but the point at which subjective analyses are introduced, and the degree of transparency in this activity differs.

Multi-dimensional integration is a subjective type of integration because the evaluation of results is heavily dependent on the interpretation and values of the assessor. Although the degree of subjectivity introduced by individual perspectives can be ameliorated by engaging with stakeholders and experts, the assessment is still based on subjective judgments. By retaining the multidimensionality of information from the results of each tool, it is however easier to identify hotspots and the potential tradeoffs between individual impact factors.

In single dimension type processes, the integration is conducted through monetization (or harmonization) of results. This process typically involves a software program that uses rules to assign values to impacts. The results from these approaches depend on type of monetization method used by the software. Whilst each individual method can be expected to provide repeatable results, there is no guarantee of agreement between different methods. Reich's (2005) analysis underlines the impact using different monetization methods can have on the results. In this paper, the researchers used 3 different methods of environmental monetization; as seen in Figure 4 the results show that different monetization methods can give substantially different results. With the exception of Yamaguchi et al. (2007) all impacts are summed up to a common unit for each pillar and then further aggregated into a final sustainability score. Yamaguchi et al. (2007) approach compares directly issues from different pillars without eliminating the multidimensionality of the results.

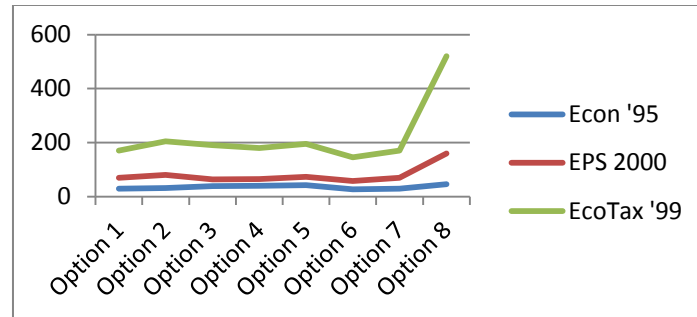


Figure 3. Environmental monetization using three different methods (results taken from Reich (2005)).

Integrated assessments with multi-dimensional and single-dimension approaches unit like monetization add another level of uncertainty and subjectivity to that which already existed because of the use of lifecycle tools (see section 1.1) this is shown in (Figure 5). Multi-dimension approaches don't have direct integration of results and so the interrelation is related to the subjective views of the assessor and the method used (i.e. risk assessment, stakeholder interviews).

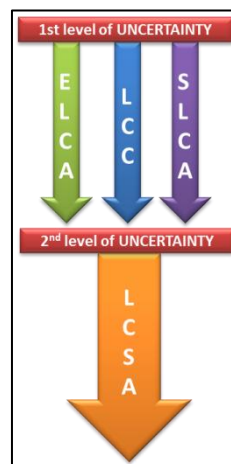


Figure 5. Uncertainty in simultaneous and integrated assessment.

## 6 Conclusions

The aim of this study was to evaluate the integration of the three lifecycle tools (ELCA, LCC, and SLCA) to help businesses take better, sustainability informed decisions. The literature review conducted was neither systematic nor exhaustive, with subjective criteria used for including papers in the study. It was found that there are few case examples of the integration of two or more life cycle perspectives and even fewer that attempt to integrate all three. Further work is therefore required to identify other attempts at integration from the literature and from practice.

A clear pattern of results emerged in the literature that was evaluated. Different approaches to integration were identified; one that preserves the multi-dimensionality of the results (multi-dimensional), and one which combines the results, aggregating the categories into scores with common

units (single-dimensional). These approaches are typical of the approaches of the evaluation of individual life cycle analyses and suffer from the same drawbacks but with amplified consequences.

The multi-dimensional approach retains the richness of the original studies but presents a very detailed and wide ranging picture which is complex to evaluate. The single dimensional approach produces simple to evaluate outcomes, but relies on monetization calculations that can produce very different results (depending on the method applied) and can also hide key impacts in the aggregation process. The interpretation of these methods therefore requires great care to ensure that decisions made as a result of the analyses are defensible and transparent. Steps that highlight (and where possible mitigate) these factors should be considered in the development a life cycle sustainability assessment framework.

## References

Guinée et al., 2006. Human and Ecological Life Cycle Tools for the Integrated Assessment of Systems (HELIAS). *Int J LCA* 11 (1) 19 – 28.

Early et al., 2009. Informing Packaging Design Decisions at Toyota Motor Sales Using Life Cycle Assessment and Costing. *Journal of Industrial Ecology*, Vol. 13, Issue 4, pp. 592-606.

Lyrstedt, 2005. Measuring Eco-efficiency by a LCC/LCA Ratio. An Evaluation of its Applicability. A case study at ABB. Master of Science Thesis in the Master Degree Programme; International Project Management. Department of Environmental Systems Analysis & Centre for Environmental Assessment of Product and Material Systems. CHALMERS UNIVERSITY OF TECHNOLOGY, Göteborg, Sweden. ESA Report No. 2005:11, CPM Report No. 2005:XX

Sundin et al., 2011. Environmental and Economic Benefits of Industrial Product/Service Systems. Proceedings of CIRP Industrial Product/Service Systems (IPS2), 13-14 April, Linköping, Sweden, pp 91-98.

Yamaguchi et al., 2007. Lifecycle Management Methodology using Lifecycle Cost Benefit Analysis for Washing Machines. 3rd International Conference on Life Cycle Management. Zurich, University of Zurich at Irchel . August 27 to 29.

Reich, 2005. Economic assessment of municipal waste management systems—case studies using a combination of life cycle assessment (LCA) and life cycle costing (LCC). *Journal of Cleaner Production* 13 (2005) 253–263.

O'Brien et al., 1996. Social and environmental life cycle assessment (SELCA). Approach and methodological development. *Int J LCA* 1 (4) 231-237.

Gauthier, 2005. Measuring Corporate Social and Environmental Performance: The Extended Life-Cycle Assessment. *Journal of Business Ethics* 59: 199–206.

Labuschagne et al., 2005. Environmental and Social Impact Considerations for Sustainable Project Life Cycle Management in the Process Industry. *Corp. Soc. Responsib. Environ. Mgmt.* 12, 38–54.

Franze and Ciroth, 2011. Social and environmental LCA of an ecolabeled notebook. LCM 2011 - Towards Life Cycle Sustainability Management. August 28-31. The dahlem cube, Berlin.

Franze and Ciroth, 2011. A comparison of cut roses from Ecuador and the Netherlands. *Int J Life Cycle Assess* 16:366–379.

Schmidt et al., 2004. SEEBalance, Managing Sustainability of Products and Processes with the Socio-Eco-Efficiency Analysis by BASF. *GMI* 45 Spring 2004 79-94.

Weidema, 2006. The Integration of Economic and Social Aspects in Life Cycle Impact Assessment. *Int J LCA* 11 (1) 89 – 96.

Buchholz T., Luzadis V., Volk T., 2008. Sustainability criteria for bioenergy systems: results from an expert survey. Manuscript submitted on July 25th 2008 upon pending invitation for a special issue on International Trade in Biofuels (ITIB) of the Journal of Cleaner Production.

Finkbeiner et al., 2010. Towards Life Cycle Sustainability Assessment. *Sustainability* 2, 3309-3322.

Peri et al., 2011. LCM 2011 - Towards Life Cycle Sustainability Management. August 28-31. The dahlem cube, Berlin.

Vinyes et al., 2011. Application of LCSA in Used Cooking Oil (UCO) waste management. LCM 2011 - Towards Life Cycle Sustainability Management. August 28-31. The dahlem cube, Berlin.

Capitano et al., 2011. Life Cycle Sustainability Assessment: an implementation to marble products. LCM 2011 - Towards Life Cycle Sustainability Management. August 28-31. The dahlem cube, Berlin.

ISO 14040, 2006. Environmental Management – Life Cycle Assessment – Principles and Framework. International Standard Organisation.

Benoit C., 2009. Guidelines for social life cycle assessment of products. UNEP/SETAC.

Guinée J., Heijungs R., Huppes G., Zamagni A., Masoni P., Buonamici R., Ekvall T. and Rydberg T. (2011). Life Cycle Assessment: Past, Present, and Future. *Environ. Sci. Technol.*, 2011, 45 (1), pp 90–96.

Klopffer W., 2003. Life cycle based methods for sustainable product development. *International Journal of LCA*, (8) 3, 157-159.

Klopffer W., 2005. Life cycle assessment as a part of sustainability assessment for chemicals. *Environmental Science & Pollution Research*, 12 (3), 173-177.

Norris G., 2001. Integrated life cycle cost analysis and LCA. *International Journal of LCA*, (6) 2, 118-120.

Stasinopoulos P., Compston p., Newell B. and Jones H., (2012). A system dynamics approach in LCA to account for temporal effects – a consequential energy LCI of car body-in-whites. *Int J Life Cycle Assess* 17, 199-207.

Huijbregts M., Norris G., Bretz R., Citroth A., Benoit M., von Bahr B., Weidema B. and de Beaufort A., 2001. Framework for modeling data uncertainty in life cycle inventories. *Int J Life Cycle Assess* Volume 6, Number 3, 127-132.

Cullen J. and Allwood J., 2005. The Role of Washing Machines in Life Cycle Assessment Studies. The Dangers of Using LCA for Prioritization. *Journal of Industrial Ecology* Volume 13, Issue 1.

Owens J., 1997. Life cycle assessment, constraints on moving from inventory to impact assessment. *Journal of Industrial Ecology* Volume 1, Issue 1.

Finnveden G., 2000. On the limitations of LCA and environmental systems analysis tools in general. *Int J Life Cycle Assess* Volume 5, Number 4, 229-238.

Grießhammer R., Benoît C., Dreyer L., Flysjö A., Manhart A. , Mazijn B., Méthot A. and Weidema B., (2006). Feasibility Study: Integration of social aspects into LCA. Available at: <http://biblio.ugent.be/input/download?func=downloadFile&fileId=633083>

Pflieger J., Fischer M., Kupfer T., Eyerer P., (2005) "The contribution of life cycle assessment to global sustainability reporting of organizations", *Management of Environmental Quality: An International Journal*, 16 (2), 167 – 179.

Weidema B., 2005. ISO 14044 also Applies to Social LCA. *International Journal of LCA*, 10 (6) 381.

Azapagic A. and Clift R., 1999. Life cycle assessment and multi-objective optimization. *Journal of Cleaner Production* 7 135-143.

Klopffer W. and Heinrich A., 2002. Life Cycle Management (LCM). *International Journal of LCA*, (3) 133.

Dyllick T. and Hockerts K., 2002. Beyond the Business Case for Corporate Sustainability, *Business Strategy and the Environment*, 11: 130-141.

SETAC, 2011. Towards a Life Cycle Sustainability Assessment: Making informed choices on products. UNEP.

Finnveden, G. and Ekvall, T. (1998). Life Cycle Assessment as a Decision-Support Tool -The Case of Recycling vs. Incineration of Paper. *Resources, Conservation and Recycling*, 24, 235-256.

Thabrew L. and Ries R., 2009. Application of life cycle thinking in multidisciplinary multistakeholder context for cross-sectoral planning and implementation of sustainable development projects. *Integrated environmental assessment and management*. Vol 5 Number 3, 445-460.

Klopffer W., 2008. Life cycle sustainability assessment of products. *The International Journal of Life Cycle Assessment* Volume 13, Number 2 (2008), 89-95.

Hunkeler D., Lichtenvort K. and Rebitzer G., 2008. Environmental Life Cycle Costing. CRC Press,



Finnveden G., Hauschild M., Ekvall T., Guinée J., Heijungs R., Hellweg S., Koehler A., Pennington D., Suh S., 2009. Recent developments in Life Cycle Assessment. *Journal of Environmental Management*, 91, 1-21.

Finnveden G. and Lindfors L., 1998. Data quality of Life Cycle Inventory data - rules of thumb, *International Journal of Life Cycle Assessment*, 3(2), 65-66, 1998.

Rebitzer G., Kohler A., Suh S., Klopffer W., Jolliet O., Saur K., 2003. Theory and Practical Implementation of Life Cycle Assessment. *Int J LCA* 8 (4) 235 – 240.

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**4c. Resource strategies: Industrial ecology, waste management; material cycles, and life cycle analysis**

**Systemic Design: Beyond Eco-design**

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oral presentation

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***Introduction***

The rapid evolution of the worldwide scenario, the climate change, biodiversity loss, resources depletion and rapid technological and social development call for radical changes. Anthropogenic pressures on the Earth System have reached a scale where an urgent change of route is inescapable.

Despite the actual environmental, economic and social crisis calls humanity for radical changes to ensure the survival of the mankind, there are new prospects that encourage “designers” to rethink the entire socio-productive system in a sustainable manner.

Therefore the main criteria for the development of eco-efficient products deal with the reduction of inputs such as material consumption and energy, the reduction of toxic and/or harmful resources, the use of biocompatible and local renewable resources, the product life optimisation by means of easy updating and maintenance procedures, a reduced semantic and functional obsolescence, the life extension of materials and the strengthening of the use phase of products [1]. Despite the “eco-friendly” products and services, use far less energy and materials than those of some decades ago, the overall consumption of environmental resources continues to increase.

This tells us clearly that even if the existent improvements are increasing, they are not enough: the translation towards sustainability requires a systemic change. It is not a question of doing what we already do better, but of doing different things in innovative and different ways going beyond the mere eco-efficiency.

We need to regain the cultural knowledge and experience that allows us to define and design production flows that can traverse different systems in a continuous process that decreases the ecological footprint of products while increasing income throughout the economy. The function of designers consists in trying to re-balance the relation between production, environment and society and in making an effort to start some interventions which maintain the balance of this mutual bond, making it better through a constant multi-disciplinary dialogue [2].

### ***Tools currently used in eco-design***

There are many approaches and different methodologies, which have been developed to improve the environmental “performance” of a product. The most common approach provides a better eco-efficiency by adopting technical or technological measure in order to reduce the environmental burdens. The Life Cycle Thinking approach aims to consider the whole life cycle of a product or service. Consequently some tools have been developed to help the designer in order to manage the increasing complexity of the design process.

#### ***1- LCA***

One of the most important tool, either in terms of methodology either in terms of appropriate software, that help the designer in the decision making phase is the Life Cycle Assessment (LCA)[3,4]. The LCA (Life Cycle Assessment) aims to quantify the impact of a product, a material or a service on the environment, assessing the environmental burden of its life cycle. LCA is frequently used to support policy making and to develop thematic areas such as integrated product policy, waste prevention and recycling, sustainable use of energy and natural resources, as well as Ecodesign. This is done through computer tools that use common and updated databases, so the analysis takes on a value scientifically recognized.

The analysis results illustrate the different phases of the lifecycle of the analysed product: pre-production, production, transportation, use and end of life. The comparison of data obtained from analysis allows to identify the most impacting phases and which aspects you should redesign to reduce the overall impact of the product.

Finally, the LCA allows to obtain an effective assessment of the most impacting elements of the product life cycle and a quantified value that is easily comparable.

However, without denying the usefulness of the Life Cycle Assessment, it is important to emphasize that it is a useful tool but not sufficient nor exhaustive to evaluate the sustainability in a complete perspective.

#### ***2- Guidelines***

The eco design is a very broad and varied topic, that is the subject of discussion and often conflicting opinions. In this context, it is often attempted to provide eco guidelines for design a product socially and environmentally sustainable.

Generally, the guidelines address many aspects of the product: energy and water consumption, reuse, ease of disassembly, packaging, etc. The main aim of the eco guidelines is to provide reasoned and experienced guidance to designers that can lead them into a design able to take into account environmental and social aspects into the project.

Together with the guidelines are often provided case studies, in order to realize the theory in a practical example. The eco-guidelines tool is certainly useful and allows the passage of information from researchers to industrial designers, offering opportunities for learning and exchange between the actors of design process.

An eco-efficient use of resources is one of the main goals that politicians as well as technicians have to fulfil if they want to establish a sustainable development model. This model has to be capable of overcoming the problems linked to the current linear system. For example, as the Club

Factor 10 studies showed, the present development model can potentially reach a 'factor of ten' reduction in input of raw materials and energy for the production of goods and services, ensuring the same level of welfare. Therefore the main criteria for the development of eco-efficient products deal with the reduction of inputs such as material consumption and energy, the reduction of toxic and/or harmful resources, the use of biocompatible and local renewable resources, the product life optimisation by means of easy updating and maintenance procedures, a reduced semantic and functional obsolescence, the life extension of materials and the strengthening of the use phase of products[5].

Below, the Authors have tried to summarize some generic criteria provided by a correct Eco-Design approach that consider whole product life cycle [6,7]:

- Definition of the real human need. According to the growing attention to environmental sustainability, products are progressively redesigned to reduce their impact on ecosystem. Usually this process of redesigning is done without reflecting on the usefulness of a specific product: nowadays a lot of products don't answer to any human need and are created because of marketing requirements. So the first question to design a sustainable product is if it is really useful and if it meets users' real needs. This approach allows to avoid upstream waste and futile objects that are immediately thrown away after purchasing because of their uselessness.
- Consumption minimization of input resources, which can be obtained by avoiding scrap production (which is nowadays a well-established process) as well as by the precycle approach (which is the practice of reducing waste by attempting to avoid its 'actual' production): material and energy inputs should be renewable rather than depleted.

The concept of input reduction should be achieved to have more and more sustainable products. An useful examples is the bottle of water: from the perspective of input reduction, a bottle made of virgin PET should be design using recycled PET or, furthermore, using bio-based PET. But according to the first eco-guideline, the matter of minimization of resources should go beyond the product, promoting the use of drinkable water directly from tap. In this way the need of users is satisfied and by dematerialization we have chosen the most environmentally sustainable approach to drinking water.

- Material Diversity Minimization in multi-component products in order to promote disassembly and value retention, ensuring that all materials and energy inputs and outputs are as inherently nonhazardous as possible.

Recently, a lot of monomaterial packaging solutions have been proposed on the market as for instance the full cardboard Biticino pack [8].

- Choice of low environmental impact resources, by using of materials and energy.

There's no an univocal way of achieve this aim, because the choice of a low impact resource is strictly connected to the local context. For instance a natural material as bamboo could be an environmentally good choice in China or other Countries were it is a native plant, instead in Europe the energy needed for transportation or the materials used in intensive cultivation make bamboo a high environmental impact resource.

- Product life optimization, making easier the upgradability and the maintenance of the components and promoting the reuse at end-of-life phase in order to extend and intensify the product useful phase. Targeted durability, which is not immortality, should be a design goal.

This approach may be interesting above all in hi-tech products, whose environmental impact in the disposal stage is very high and often they are thrown away because of their technological obsolescence. The designer Sam Hecht designed in 2007 for LaCie [9] the family of media driver Little Disk Program: the body shell is not painted, is mono-material (made in ABS) and has easy connections so as to optimize recycling. Inner components can be bought separately so that they can be replaced, updated and collected apart. These products show a new positive approach both for environment and users.

- Extension of material life span, using recyclable materials and encouraging their recovery at the end of life. This can be done thinking of a reuse of products in the designing stage: the Clever Little Bag by Puma [10] reduces the paper used for shoeboxes by 65%, re-placing the traditional box with a re-usable bag that, after purchase, can be used as shopper.
- Design for disassembly, planning the product disposal in order to promote the recovery or recycle of its components.
- Raise the environmental awareness of users through the correct use of the product.

The labelling is an important tool to communicate the product information concerning the sustainability, the origin or other main characteristics of the products, so to allow an aware purchasing. Nowadays labels are used above all to show the brand image and spread the imaginative world created around the product. On the other hand we can find some examples of smart labelling that shows the correct information about product and show how to properly collect it.

- Dematerialization of the product, which refers to the possibility to integrate and reduce the components number to create a flexible product-system in which some parts can be shared by different models in a modular way. It is better to prevent waste than to treat or clean up waste once it is formed. Design of products, processes and systems must include integration and interconnectivity with available energy and materials flows.

An useful example is the Mac book Air designed by Apple [11]: it has a unibody shell for both the enclosure and the display, so to minimize the components; the flash chips are directly placed on the logic board, so they take up about 90 percent less space, that allows to have a bigger battery. By reducing components, the computer has better performances and is lighter and more durable.

- Design considering different users that will interface with the product during all his life cycle (skilled worker, end user, maintenance man, etc.).

In recent years one of the most common strategies for making eco-friendly products, also because of improved technologies, is the dematerialization of products. Being able to minimize the material content of products has a positive impact on the environment because it reduces the environmental rucksack associated with it.

In extreme cases you get to replace the product with a respective service, so to reduce further the impact related to all phases of the product lifecycle.

Design the service by offering the solution instead of the product and by using robust and state-of-the-art machines at maximum capacity would create a whole new dimension to saving resources.

## ***Limits***

### ***1- LCA***

One of the main criticalities of LCA Analysis concerns the interaction between the different actors of the evaluation process: the analysis is commonly carried out by engineers in the environmental field, after the design phase. Therefore, often there is not dialogue between the designer and the person carrying out the analysis, so it has a loss of from the design to the environmental assessment. In this way there isn't any possibility of a contextual improvement of the project and, at the same time, the environmental engineer could make an uncorrected assessment of the product.

Furthermore there are also some criticalities about the tool itself concerning for instance the quality and reliability of data. The high level of uncertainty could deeply influence the reliability of the results by giving inadequate suggestions for the designer choices.

However the main criticalities do not belong to the tool itself but in the way it may be used.

Moreover the LCA Analysis provides quantitative data relating to environmental aspects but it does not consider qualitative aspects related to the product and the context.

The LCA, in fact, is a useful tool in providing indications of environmental burdens, but it can not replace the ability of the designer that is able to assess aspects that the LCA model could not include as for instance the behaviour of people and their education to an eco-friendly use of the product.

It seems clear that the eco-design approach can not be based solely on the analysis LCA, but it needs a wide perspective in which the LCA could be a useful tool.

### ***2- Guidelines***

Eco guidelines are designed in theory to fit a very broad type of products and services, taking into account that there are many solutions to create an eco product. The result is a collection of useful and reasoned information but often too generic, since they all relate to the phases of the lifecycle of the product and affect various aspects of design and production or disposal processes. Because of the breadth of topics covered in the guidelines, often several guidelines may be irreconcilable with each other or in the specific project. For instance, a product can be designed to be functionality adaptive to the user's habits, in order to create affection and increase the duration of its life cycle (according to the concept of fuzzy logic); this, however, may require the use of more materials and of electronic parts, in contrast to guidelines that suggest to use only one material and avoid materials with a heavy rucksack (many of which are present in electronic circuits).

The vagueness and the incompatibility of the guidelines make the role of the designer even more difficult, as well as the way towards the creation of truly sustainable product.

The second issue is the discretion of the guidelines: as already noted, the guidelines are very general as they relate to heterogeneous categories of products. It is the responsibility of the designer fit the specific case. The application of a guideline is therefore a choice of designers, that often, if they have not a good education in environmental sustainability, may adapt it to their liking, bowing to economic and marketing needs of the product. The main problem is that some companies could use this lack of clarity in their favour: by *greenwashing* operations or commissioning ecological production of *environmental simulacra*. The *greenwashing* is a marketing strategy, which deceptively promotes the aims

and policies of an organization as environmentally friendly; it is used to increase profits or gain popular opinion support. Instead the *environmental simulacra* are products that, because of guidelines to which they refer, are presented as environmentally sustainable even if they are not really.

### ***The New Approach: quali-quantitative***

All the considered solutions are certainly useful design and analysis tools, which led to significant improvements in the sustainability of the product. However, they are not sufficient by themselves, and need a wider and more significant system to fit in, as important but partial environmental assessment and design tools.

A complex approach may provide new perspectives for problems that cannot be easily addressed within a single discipline. On the basis that living systems are open, they continually draw upon external sources of energy and maintain a stable state of low entropy, as the physicist Erwin Schrödinger asserted in 1946; some of the next theories on industrial processes applied that concept also on artificial systems. Material and energy loops are open in order to decrease environmental impacts and resource depletion.

The Systemic Design (SD) here presented, is, above all, a different model of economy, which puts in action a network of relations in order to turn the outputs of a production system into resources (inputs) for another one, in a local context: a virtuous cooperation among production processes (agricultural and industrial) and the system of natural kingdoms, the territorial background and the community (Bistagnino, 2011) [12]. The interest moves from a product-oriented approach to an approach focussed on the social and environmental network in which the need is conceived.

Humans have always looked at Nature as a model to answer their questions. SD approach aims to “learn from nature” to establish a change in the point of view in which we consider the environment. Industrial development has always been based on the intensive exploitation of natural resources and consequently on the dangerous emissions to the environment. Rather the production activities should imitate the principles of the metabolic process of Nature: living systems in constant change which jointly make progress, keeping their own typical relational structure.

In this way the SD plans open systems tending to zero emissions, in which the concept of waste does not apply anymore: any process output is fully employed as input in other processes. It is not an “end of pipe” approach oriented to limit the damage of a system no longer sustainable, but a radical change that releases opportunities and highlights perspectives, quite unthinkable only few decades ago. The resulting design approach is then made up by the product design and the strategic design, and it is oriented to design and manage the entire product system taking into account the relationship with the environment and people.

### ***Conclusion***

In conclusion there was a remarkable effort in terms of research and social commitment to attain eco-efficiency, but the overall framework has to be improved.

During the last decades, there has been a radical change in the concept of Eco-design that William McDonough [13] has defined as the transition from eco-efficiency to eco-effectiveness. Indeed, if the goal of eco-efficiency is to eliminate or reduce the damages caused by processes and products not designed considering the environmental impact, eco-effectiveness aims to outline a new design approach inspired by the natural system that encompasses a cultural, social and economic change, commonly referred as the Third Industrial Revolution [14].

Humans have always looked at Nature as a model to answer their questions. Eco-effectiveness approach aims to “learn from nature” [15] to establish a change in the point of view in which we consider the environment. Industrial development has always been based on the intensive exploitation of natural resources and consequently on the dangerous emissions to the environment.

The eco-effectiveness produces “Zero Emissions” systems, in which the concept of waste does not apply anymore: any process output is fully employed as input in other processes. It is not an "end of pipe" approach oriented to limit the damage of a system no longer sustainable, but a radical change that releases opportunities and highlights perspectives, quite unthinkable only few decades ago. The understanding of the raising complexity, resulting by the discoveries occurred during the last century in Physics and Biology [16], made the reductionism view inadequate: as a consequence the designer point of view moved from “the parts” to “all”. The resulting design approach is then made up by the product design and the strategic design, and it is oriented to design and manage the entire product system taking into account the relationship with the environment.

To be able to manage this new complexity, the designers have to increase their level of knowledge of ecological literature, or eco-literacy, carefully evaluating the impact of design choices on the environment. According to Janine Benyus this change “introduces an era based not on what we can extract from nature, but on what we can learn from it” [17]. From this point of view, the research in the field of biomimicry (from ‘bios’ meaning ‘life’, and ‘mimesis’ meaning ‘to imitate’) is offering interesting ideas to transfer the production mechanisms developed by nature, over millions of years of evolution, into possible applications that can meet human needs. For example, there are studies concerning the processes for which the spider is able to make a silk “similar” to Kevlar, acting at the temperature and pressure of the surroundings and with no damaging output to the environment. Despite the actual environmental, economic and social crisis calls humanity for radical changes to ensure the survival of the mankind, there are new prospects that encourage “designers” to rethink the entire socio-productive system in a sustainable manner.

The SD research team at the Politecnico di Torino is improving this methodology through rethinking productive processes in a systemic way since ten years. During this period the SD research team has collected some case studies with the aim to produce benefit for the whole community: total reduction of the production output, creation of new job placements, increasing gains for companies and individuals, new virtuous cooperation among different people and better environmental quality.

## ***Bibliography***

- [1, 5] LANZAVECCHIA C., Il fare ecologico, Paravia, Torino, 1999
- [2] TAMBORRINI P., (2009), Design Sostenibile Milano: Electa
- [3] ISO EN ISO 14040 (2006), Environmental Management.Life Cycle Assessment.Principles and Framework.
- [4] ISOEN ISO 14044 (2006), Environmental Management.Life Cycle Assessment.Requirements and Guidelines.
- [6] ANASTAS, P.T., AND ZIMMERMAN, J.B., "Design through the Twelve Principles of Green Engineering", Env. Sci. and Tech., 37, 5, 94A-101A, 2003.
- [7] VEZZOLI C., MANZINI E., Design per la sostenibilità ambientale, Zanichelli, 2007
- [8] DOSSIER PREVENZIONE CONAI (2011)
- [9] [www.lacie.com](http://www.lacie.com)



- [10] [www.puma.com](http://www.puma.com)
- [11] [www.apple.com](http://www.apple.com)
- [12] BISTAGNINO LUIGI, Design sistemico. Progettare la sostenibilità produttiva e ambientale, Slow Food, 2009
- [13] MCDONOUGH WILLIAM, BRAUNGART MICHAEL, Cradle to Cradle, North Point Press, New York, 2002
- [14] PAULI GUNTER, Breakthroughs – What Business Can Offer Society, 1996
- [15] PAULI GUNTER, Blue Economy-10 Years, 100 Innovations, 100 Million Jobs, 2010
- [16] CAPRA, F. The hidden connections: A science for sustainable living. London: Flamingo (HarperCollins), 2003
- [17] BENYUSJANINE, Biomimicry: Innovation Inspired by Nature, 1997

## **Grassroots Sustainability Associations: Creating Places for Sustainable Consumption Practices**

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**Track 4d: Sustainable Consumption and Lifestyles.**

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### **Abstract**

It is now widely recognised by academics in the field of sustainable development, practitioners, and policy makers that community participation is vital for the transition to sustainable development. In recent years there has been a surge throughout the United Kingdom of people connecting with others in their community to collectively tackle issues of sustainable consumption. These include not only geographic communities e.g. neighbourhoods but also communities of work, education or leisure. Many of the associations that are formed create projects that allow users to consume resources more sustainably, such as garden-share schemes, energy libraries, food co-operatives, farmer's markets, and organic vegetable growing classes, to name just a few. They may also arrange and participate in protests and lobbying in order to change government policy. These groups add to the pluralistic approach to sustainable development by creating niche places in which they educate and enable others in the community to consume sustainably. I have termed these groups "grassroots sustainability associations".

This paper reports on findings from a pilot case study using qualitative interviews with members of a grassroots sustainability association called Green Action, based in the student's union at the University of Leeds, UK. This paper demonstrates how in the case study, places such as an allotment and food co-op have become places for gaining knowledge and skills for sustainable consumption. It will demonstrate how the learning that occurs in these places creates more human resources for the association, thus adding to the capacity of the

association to meet its aim of being a “working practical example of an/the alternative autonomous lifestyle which we are hoping to move towards” (Green Action 2011). The paper explains that Green Action has successfully created not only systems for sustainable consumption but also alternative niche places for learning about sustainable consumption issues and ways of addressing them, within the mainstream academic system of the university. The paper concludes by explaining how the findings have academic implications for our understanding of how grassroots sustainability associations operate and will discuss the findings in relation to existing literature.

## **1. Introduction**

It is generally accepted by those working in the field of sustainable development that unsustainable development and the gross inequality in the world is largely due to overconsumption by citizens of developed countries (Jackson 2009; Seyfang 2009; Rees 2008; Carley and Christie 2000). Grassroots sustainability associations (GSAs) are one method through which problems related to unsustainable consumption are being addressed. I define a “grassroots sustainability association” as a named group of volunteers that share concern for sustainability problems and that aim to encourage and enable themselves and others in the community to contribute to achieving local and global sustainability. GSAs rely on the knowledge and skills of their volunteers as they have no (or very few) members of paid staff and usually few other resources that they can use to meet their aims. This paper reports on findings from a pilot study with a GSA called Green Action based in the student’s union at the University of Leeds. It examines the skills and knowledge acquisition of volunteers belonging to Green Action, and considers the learning processes that are involved as skills and knowledge are transmitted from one member to another in the context of place. In doing so, it adds to the literature on skills for sustainable communities.

## **2. Grassroots Sustainability Associations**

Grassroots sustainability associations create places in which to bring together the skills and knowledge of people in the local community (whether a neighbourhood, or community of work, education or leisure). Examples of projects that GSAs may initiate are: Energy libraries (where people can borrow energy-saving or energy-monitoring equipment), garden-share schemes (where a member uses another member’s garden to grow fruit and vegetables), farmer’s markets, food cooperatives, recycling services, car-share schemes, awareness-raising events, and many more. In providing these projects GSAs “are developing radical new

conceptions of livelihood and economy” and challenging mainstream ideologies of economic growth and mass consumption (North, 2010, p.586). GSAs are concerned about present unsustainable levels of consumption and believe that people can live resource-poor but satisfying lives (North 2010). Although they may not use the term explicitly, GSAs often believe in the values of “voluntary simplicity,” principals built on a simple life with minimal consumption (Elgin 1993). GSAs form because some communities are recognising that sustainability and the related problem of climate change are prominent global issues that require a response at the community level. This communitarianism recognises the importance of collective responsibility over individual rights (Harvey 2000). It seems that some communities are beginning to view sustainability as a “post-political” problem (Swyngedouw 2007); a crisis that must be addressed by society as a whole. Therefore, GSAs form “when formal, state systems of control are perceived as inadequate” (Cable and Benson 1993, p.468). Some GSAs appear to view governments as responsible for “sustain[ing] unsustainable economic institutions and ways of life” (Shove 2010, p.1274). GSAs therefore, provide a niche form of local governance (Seyfang 2009). The close proximity of GSAs to their community means that local people may trust GSAs more than government or businesses (Middlemiss 2009).

Research by Middlemiss (2009, 2011) indicates that GSAs can impact positively on their members’ consumption patterns. She claims that this is enabled by the GSA providing a range of resources and rules. Resources are anything that enables the association to accomplish collective goals and rules are norms that are socially constructed. These resources and rules are explained in Table 1.

**Table 1. Resources and Rules Provided by Grassroots Sustainability Associations**

<b>Resources/Rules</b>	<b>Explanation</b>
Organisational resources	Bringing participants together, running activities, providing leadership, creating partnerships, accessing resources for the organisation
People resources	Participant’s access to personal resources and capacity to volunteer
Infrastructural resources	Providing information, services or facilities for participants.
Cultural rules	Embedding the idea of sustainability within the community; creating a positive association with sustainability

Source: Middlemiss (2009).

Having a high level of access to these groups of resources contributes positively to the GSA's capacity to enable sustainable consumption patterns to occur in their members and so to contribute to the transition to a sustainable society (Middlemiss 2011). Organisational resources are the "social, economic and human capital" that the GSA has access to (Middlemiss, 2009, p.256). The organisational and infrastructural resources that GSAs generally hold mean that they are well suited to experimenting with innovations for delivering sustainability due to their informality and flexibility (Smith 1997). Cultural rules refer to what Alexander, Hope and Degg (2007) call "mainstreaming" sustainable development; promoting sustainable development as the norm. Arguably, the most important types of resources within GSAs are people resources. GSAs help to connect different 'types' of people who possess a variety of people resources, such as skills and knowledge, who would not normally associate with each other (Smith, 1997). GSAs create places in which knowledge-transfer and skills-learning can take place, which can be important for generating innovative ideas and methods for tackling sustainability problems. Communities can pool their resources by forming GSAs, and use their resources for the advantage of sustainability (Berkowitz 1996). Members of GSAs are architects of places in which these resources are put to use. Viewing members as architects allows us to emphasise their agency and the need for resources to support this agency. While GSAs may contribute to achieving sustainability, it is not expected that they will alone solve the problem. The projects of GSAs are usually small-scale and of limited scope. Sustainability also requires the engagement of other stakeholders such as governments and businesses.

### **3. Skills and knowledge for sustainable communities**

GSAs need to mobilise the knowledge and skills of their volunteers in order to create sustainable communities as they usually have no (or very few) members of paid staff and often have few other resources to draw on. The current debate on the skills and knowledge needed to create sustainable communities has however, largely focused on the role of professionals and has neglected grassroots and community associations that rely on volunteers. According to the *Egan Review: Skills for Sustainable Communities*, creating sustainable communities requires "not only the professional skills of planning, architecture and surveying, but also a broad range of generic skills, behaviour and knowledge – such as governance of communities, economic planning for prosperity,

communication (especially listening to and selling to communities), risk taking, and above all leadership and partnership working” (OPDM 2004, p.4). The review reports that there is a lack of generic skills among those in “core” occupations (those who spend all or most of their professional time creating and maintaining sustainable communities).

Until recently the literature on skills for sustainable communities has had little focus on sustainable consumption issues and the skills and knowledge of community groups attempting to address these issues. Newton et al (2008) argue that the literature on skills for sustainable communities should consider issues of sustainable consumption and behaviour change as consumer behaviour is largely accepted to be a major cause of unsustainable development. Newton et al (2009) noted that there has been a gap in the literature on sustainable communities with regards to the processes of learning in a social context and argue that research in this area should focus on “the everyday lives of people in place” (ibid, p.33). They argue that the literature on sustainable communities needs to provide “an understanding of how different skills come together in place and the process of how skills and learning are acquired and used” (ibid, p.24). Their 2009 case study used Stroud as the “place” in which to study the learning processes of skills and knowledge for sustainable consumption. They identified several qualities of Stroud (such as a strong sense of community) that helped the town to develop its reputation as a sustainable community. One of their findings was that “learning by doing” or “learning by seeing” was more effective than formal learning for stimulating sustainable practices. Their work demonstrates the “importance of bringing people *together* with different skills sets and lived experiences” (ibid, p.29). There remains a gap in the literature however, on the learning that occurs in “places” that are purposefully created by such groups for their activities (such as allotments, food co-operatives etc).

#### **4. Place**

In recent years there have been calls for researchers to look beyond what types of skills and knowledge are needed for sustainable communities and to also examine learning processes along with the context in which learning occurs (Newton et al. 2008; Newton et al. 2009; Franklin et al. 2011). Grassroots sustainability associations are a type of “grassroots innovation” (Seyfang and Smith 2009). Seyfang and Smith define grassroots innovations as “a network of activists and organisations generating novel bottom-up solutions for sustainable development and sustainable consumption;

solutions that respond to the local situation and the interests and values of the communities involved” (2009, p.64). The authors argue that grassroots innovations provide niche *space* “where the rules are different” and niche innovation and social learning occurs (Seyfang and Smith, p.72). I argue however, that the concept of “place” is more relevant as the context for understating the learning processes of GSAs than the concept of “space” as GSA activities (including learning) occur in places of meaningful interaction. A discussion on place as a concept is presented to illustrate why this concept has been chosen over the concept of space.

Place is a contested concept (Cresswell 2009). However, it is generally agreed that a space becomes place when meaning is ascribed to it (by human beings). “The ideas “space and “place” require each other for definition. From the security and stability of place we are aware of the openness, freedom, and the threat of space, and vice versa” (Tuan 1977, p.6). For Agnew (1987) place is made up of three features: location, locale and sense of place. “Location” is simply the fixed co-ordinates from which a place can be found. By “locale” Agnew is referring to the ““microsociological” content of place” – the material setting where social interaction takes place (1987, p.5). “Sense of place” is the subjective attachment that comes from experiencing place. “Experience” is essential to the concept of place (Cresswell 2009). Place has been defined as “the *experience* of a particular location with some measure of groundedness (however, unstable), sense of boundaries (however, permeable), and connection to everyday life, even if its identity is constructed, traversed by power, and never fixed” (Escobar 2001, p.140, emphasis added). Tuan (1977) argues that one person’s experience of place can be different from another person’s experience of the same place.

Tuan argues that place is a “static concept” (1977, p.179). He states that “place is pause” because if it were a process then one would not be able to develop a sense of place (1977, p.6). Pred (1984) however, views place as process; as becoming. Pred argues that place is “what takes place ceaselessly, what contributes to history in a specific context through the creation and utilization of a physical setting” (1984, p.279). Pred, drawing on structuration theory, argues that place is created and re-created through social structures and therefore, place is never “finished”. Humans create place and they can also change it. He refers to those that contribute to place-making as “process participants” (1984, p.280). Seamon (1980) also uses structuration theory to

argue that space acquires meaning (and becomes place) through the reproduction of practices that are both individual and social at the same time.

The concept of place has been used in this paper as the arenas in which GSAs conduct their activities are not voids as the concept of space suggests but are in fact places of meaning and ideology that are socially constructed and experienced by GSA members. This paper addresses calls to examine the learning processes that create skills and knowledge for sustainable consumption in context; in this case the context being the places that the GSA creates.

## **5. Research Questions**

The research questions were concerned with social learning in Green Action, how skills and knowledge are transmitted between members in “place” created by the association, and the importance of this for the association. The research questions were broad enough so that they could be applied to all grassroots sustainability associations and not just Green Action.

- (1) What skills and knowledge for sustainable consumption do members share with each other?
- (2) How are skills and knowledge for sustainable consumption shared with other members?
- (3) How does “place” shape the sharing of skills and knowledge for sustainable consumption practices?
- (4) How does the sharing of skills and knowledge for sustainable consumption aid the collective aims of the association?

## **6. About the Case Study**

Green Action is a student society based in the student’s union at the University of Leeds. Although they are a student society they try to engage others from the wider Leeds community. The association has approximately four hundred members and an estimated thirty to fifty active volunteers (Interview with Participant 2). Established in the early 1990’s the association introduced a recycling scheme in the LS6 postcode area, where most University of Leeds students live, before the council introduced recycling bins. They run a food co-operative in the student union that is open 10am-6pm Monday-Friday, staffed entirely by volunteers. The co-op sells vegan products such as grains, tofu, and soya products at cost



price, meaning that Green Action does not profit from the sales. Membership of Green Action costs two pounds per year to cover losses (such as spillages) at the co-op. They also provide organic fruit and vegetable boxes once a week via a local farm. Green Action also has two allotment plots close to the university that members can use either by going along to the weekly group session or, if they want to go on their own, they can use it any time during the week. They have an alternative library where members can borrow books about food, gardening, and sustainability; they also produce a Green Guide to Living in Leeds at the start of every academic year; run skills-share workshops; and get involved in many campaigns such as Buy Nothing Day. The group is non-hierarchical meaning that there is no leader as such but there are co-ordinators for each project (e.g. allotment, food co-op). The association is run by consensus decision making meaning that every member should be allowed a say in the running of Green Action.

At the AGM held in 2010 Green Action came up with four principles that they feel capture what they stand for: Environmental, Practical, Educational and Community Focused. Officially Green Action aims to “be a working practical example of an/the alternative autonomous lifestyle that we hope to move towards” (Green Action 2011). The first Green Action Newsletter produced in December 2011 explains that:

“Instead of buying food that we have no control over – like that in supermarkets – we’ve created the co-op so we know where our food comes from. It has worked for over 15 years and operates out of an ecological rather than economic framework. Combined with our allotment, where we get on with growing our own, we see this as an *educational platform* to create the world we want to see” (Green Action 2011; emphasis added).

Education is one of the four principles of Green Action and was also mentioned in their first ever newsletter. The places that Green Action has created that allow members and the wider community to learn about sustainable consumption practices through sharing their skills and knowledge will be the focus of this paper.

## **7. Methods**

An email was sent to all Green Action members to ask them to complete an online survey about their involvement with Green Action. Surveys were also administered at a Green Action meeting and were left at the Green Action Co-op for members to complete. Twenty-nine completed surveys were collected altogether. From these twenty-nine, ten members were

interviewed and two co-ordinators. Participants were sampled for a variety of how long they had been a member of Green Action and the projects that they had been involved with. The age of the participants ranged from nineteen to twenty-six years old. The participants were asked questions about their volunteer work with Green Action; about any learning that occurred through Green Action, and about their contribution(s) to the association in terms of knowledge and skills. The co-ordinators and some long-term members were asked to provide some background information about Green Action. Interviews ranged from approximately fifteen minutes to an hour and a half (on average being fifty-two minutes long) depending on how long the participant had been a member and the range of projects they were involved in. The interviews took place in common places within the university to provide a relaxed atmosphere so that the participants would not feel intimidated and would hopefully be forthcoming with their responses.

## **8. Places for Learning about Sustainable Consumption**

### **8.1. The Food Co-operative**

Green Action members ascribe meaning and values to the spaces they occupy, creating niche places. To non-members the Green Action Co-op may seem like any other wholefoods shop. However, the members of Green Action ascribe alternative values to the co-op and insist that it is not a shop at all:

[Y]ou meet some really interesting people, and it's quite nice to be able to explain to people who come to the co-op what it is and the fact that it's not a shop. 'Cause it isn't, it isn't a shop. I don't see it like that, I see it as, I don't know, a real alternative to shopping...(Participant 8).

We're not a shop. It's definitely not a shop. It's a co-operative and we're a community that enjoy like, having access to cheap, good food and stuff but we're also a community of people that want to teach and share skills and ideas...(Participant 3).

Many of the participants were eager to stress that the co-op is a "unique" place and should not be seen to be the same as the shops in the student's union (Participant 9). They explained that "we shouldn't just be a shop; there needs to be reasoning behind it" (Participant 7) and it is in fact a "place of education...not just a shop" (Participant 3). One participant believed that the co-op educated people just through its presence:

[W]e probably educate people just by being...Just because we have organic stuff, because we don't have honey, so think about it, why should we not have honey? Things like that (Participant 6).

Participant 6 felt that by providing a place for sustainable foods and for excluding unsustainable foods people would question these choices and learn from them.

Members of Green Action use the co-op as a place for socialising and as the “linchpin” of the association (Participant 4). It is what occurs in this place that is important; it often becomes a place for informal learning. As the participants were eager to explain “[T]he co-op...can often become the centre for discussions” (Participant 3).

“...[J]ust through having conversations with other volunteers I think inevitably you're going to learn stuff...just kind of because of the common umbrella of being in a co-op I guess. It's going to inevitably shape the kind of things you discuss” (Participant 9).

Through these discussions “there is a lot of skills sharing and learning that takes place in the co-op...” (Participant 5). Several participants told of their learning experiences while volunteering in the co-op:

[P]eople are so, so friendly and just to talk to the people who come to you and like share their knowledge and you share your knowledge and...there's coming together through the shop (Participant 6).

It might just be you're at the co-op on your shift and you're talking to the person you're with, or someone who you're serving or who's serving you...and these topics all come up and it's really interesting and you find out loads of new things (Participant 1).

So yeah, I'll chat to whoever I'm working with about the reasons I became vegan and just general stuff but also yeah people who come [to the co-op]. I have the whole spectrum of their understanding and knowledge about veganism and stuff like that. It's...a good place to discuss things (Participant 9).

Through the co-op members informally gain knowledge and skills that they can use in other areas of their life.

[The co-op] is such a communal space where a lot of people will go and hangout, like I know someone who does knitting in there and I've seen someone being taught knitting by her (Participant 5)

Through this informal learning the member that has been taught to knit has gained an important skill that can help him/her to live more sustainably by making their own clothes and accessories rather than having to buy them. For one participant learning about the co-operative model of business through his volunteer time has had a profound effect on how he imagines his life after university:

It's definitely got me thinking a lot about erm, what I want to do sort of with the rest of my life. I can't really imagine working for a company that isn't a co-operative I guess. It's kind of my introduction to a co-operative; it's really useful in that sense that it's an easy thing to get into that kind of shows you an alternative of a business structure, even though I don't really see it as a business at all (Participant 9).

By providing a place to learn about co-operative models it allows participants to imagine what other areas of their life could be like. Although the co-op may be a small place in comparison to some of the shops in the student union it clearly has a big impact on its members, and as one participant put it: "It's quite lovely actually that there's not so much space because it's like it shows you don't have to have such a luxury and it still works" (Participant 6).

In creating the co-op as an alternative system of food provision, Green Action has also created a niche place where members share their knowledge and skills for sustainable consumption. This niche place influences what members discuss and learn while they are experiencing the place. Green Action members seem to have a sense of place attached to the co-op as they identify it as unique from other shops in the university and consider it to be a place for learning.

## **8.2. The Allotment**

Like the food co-op the allotment has also become a social place where learning occurs. The allotment was described as a place "where friendships are formed" and many participants said that friendships were important for their continued involvement with Green Action (Participant 4). The group sometimes have meals around a campfire at the

allotment and important discussions involving the allotment can occur during this time. The allotment however, is more than just a place for socialising and making friends. The allotment co-ordinator described the allotment as a place for learning and explained that:

For me, it's about it being a much more educational thing that people get to engage with as an experience (Participant 9).

Members do not have to have any prior knowledge or skills in order to get involved. The co-ordinator explained that before becoming co-ordinator she had very little knowledge of growing her own fruit and vegetables but has learnt by experimenting along with other members.

I can't express enough how much this has been a learning experience for me (Participant 9).

She explained that she found that learning through participation and discussion with other members was much better for gaining practical skills than through reading books. This supports Newton et al's (2009) finding of the importance of "learning by doing" and "learning by seeing" for performing sustainable consumption practices. The co-ordinator stressed that the allotment was not a place for formal learning and should not be treated as a class but that members could pick up knowledge and skills as they work with others and "give it a go".

Some members do have previous knowledge and skills from elsewhere that they bring with them to the allotment. For example, a member had created a herb spiral from bricks to allow the various herbs to get the different amounts of water that they need. One of the members who had knowledge of permaculture practices discussed how she would like to bring her knowledge to the association by "sharing some of the ideas I've learnt, telling people about them, and discussing them together" (Participant 8). This quote demonstrates the informal nature of learning that takes place at the allotment and also stresses the importance of the group learning and making decisions together so that they feel ownership of the allotment. This was stressed several times by the participant:

'Cause I feel like it's all very well me bringing in permaculture ideas but it's not, it's not *my* allotment so I want other people in Green Action to get enthusiastic about it and learn a bit about it as well (Participant 8).

One member's knowledge and skills can be transmitted to the group and then each member of the group can pass these on to others. As Participant 2 explains:

[The allotment] gives people who have been acquiring the skills, like gardening and cultivation skills [the opportunity] like to pass these skills to people in a very informal way, at their own pace. So at the other end it helps people [to acquire] the skills whenever they feel like it (Participant 2).

This transmission of these skills and knowledge between members in a place that has been created by Green Action is important because it means that the association has more human resources that it can mobilise for its allotment project therefore, increasing its capacity to meet its aims. This transmission of skills and knowledge also increases the sustainability of the association itself as every year some of its members graduate the university and leave Green Action taking their skills and knowledge with them but if these have been transmitted to others then they can be passed down the generations of Green Action members.

### **8.3. Workshops**

Green Action has run several workshops such as jam making, soap making, energy efficient cooking, skipping (taking food that has been thrown out by supermarkets), and many more. The workshops are places for equipping members with practical skills for sustainable consumption. As Participant 9 explained:

[Workshops are important for] empowering people through giving them the practical skills to live differently and showing you how simple it can be I guess to do things that seem like very radical steps towards alternative lifestyles (Participant 9).

Participant 3 explained about a skipping workshop that she attended and the educational role taken on by the workshop co-ordinator.

[In workshops] they'll always be conscious of...their social and educational role. For example, skipping workshops...a team's been taken out to find out about...what kind of waste problem there is with supermarkets and large companies, how you can benefit from that but also what are the sustainable kinda impacts of that. Like, there's always a sort of conscious self-reflection... (Participant 3).

In the example given by Participant 3, members were not only being taught how to do skipping but were also being educated about why skipping is important for someone who wants to consume sustainably. Participant 3 went on to explain how she had shared one of her own skills with other members:

Yep, we...got a load of people, put up some posters, skipped a load of fruit and erm, yeah, did, made ridiculous amounts of jam. It was wonderful. It was a great jam making day. And then everyone's got a skill of something, that they've learnt how to make their own jam. They don't just always have to go to a supermarket...They can make it themselves, and I think that's exciting (Participant 3).

Skills-sharing was seen to be an exciting and fun experience by several of the participants that had facilitated workshops:

Okay so, it's part of the freedom of Green Action, obviously if you've got something you wanna share with people you...organise a workshop erm, and there's a lot of flexibility within the society to be able to do that. Erm, what we wanted to do with the, with the soap making workshop was to encourage a kind of alternative Christmas... Erm, and it was really good fun and it means that you know, people have got a slightly different present to give this Christmas then they would do otherwise.

The quotes from participants 3 and 7 demonstrate the enthusiasm that some members have for being able to share their skills with others; something that is unlikely to happen without a place for it being provided by Green Action (Participant 7).

The workshops are purposefully created niche places for members to gain skills for sustainable consumption. Workshops were described as “fun” and “exciting” therefore encouraging members to attend. Through acquiring skills at the workshops members can consume some foods more efficiently and it also allows them to consume outside of the mainstream.

## **9. Discussion: Creating Places for learning about Sustainable Consumption Practices**

I argue that the concept of *niche place* is more appropriate than that of niche space (as previously used by Seyfang and Smith 2009) for understanding grassroots sustainability associations as Green Action members clearly assign meaning to the settings where

they interact. Green Action members have successfully created alternative niche places for systems of provision for sustainable consumption and have done so within the mainstream academic institution of the university. They do more however, than just provide the systems; these places also enable members to equip themselves with knowledge and skills needed for sustainable consumption. Members are “active agents in the appropriation of knowledge” (Lave 1990, p.325). The skills that are transmitted appear to mostly be those that promote a “do it yourself” ethic and self-reliance (such as example of the jam-making workshop and the experimentation with growing practices at the allotment). More general knowledge about sustainable consumption practices is acquired at the co-op; for example, the importance of a vegan diet. The findings support the argument made by Netwon et al (2009) for the importance of “learning by doing” and “learning by seeing” for the transfer of skills and knowledge for sustainable consumption. Members also learnt through others who shared their life experiences, for example, learning about veganism through other vegan members that use the co-op. This learning was often unintentional and not necessarily actively sought out but it seemed that it was always eagerly received by the beneficiary.

By learning from each other, members are able to take on sustainable consumption practices that they would have been unable to otherwise. It is important for members to learn *how* to consume sustainably rather than just be provided with the means for sustainable consumption practices if they are to practice sustainably in other places away from Green Action. By members sharing their skills and knowledge with others it ensures that those human resources stay within the association when they leave. This all adds to Green Action’s capacity to be a “working practical example of an/the alternative autonomous lifestyle which we are hoping to move towards” (Green Action 2011).

To act ethically towards all others Harvey argues, requires “the construction of discursive regimes, systems of knowledge, and ways of thinking that come together to define a different kind of imaginary and different modes of action [from the mainstream]”; and this is what is being provided by Green Action in various niche places (2000, p.214). Green Action members can be viewed as architects of the spaces in which they transmit knowledge and skills as “[t]he architect shapes spaces so as to give them social utility as well as human aesthetic/symbolic meanings” thus turning them into places (Harvey 2000, p.200). This has been demonstrated throughout the case study. Green Action members can be viewed as “process participants” as they ascribe



meaning to places that are constantly developing as members join and exit the association, creating different combinations of skills and knowledge which shape the places discussed (Pred 1984, p. 280). The places created and re-created by Green Action can be seen as processes rather than as “finished”.

## **10. Conclusion**

This paper has reported on a pilot case study of a grassroots sustainability association called Green Action based in the student’s union at the University of Leeds. It found that Green Action does not just simply deliver “systems of provision” for sustainable consumption (Fine and Leopold 1993). Members are encouraged to be “active agents” and there is a great deal of new knowledge and skills that members learn to be able to consume sustainably in order to create a sustainable community with the university (Lave 1990). Green Action provides “a world within a world,” with niche places that break up the mainstream landscape of the university (Seyfang 2009, p.76).

An argument has been made throughout the paper for the use of the concept of “place” for understanding grassroots sustainability associations. Academics should also consider how places in mainstream regimes might become places in which skills and knowledge for sustainable consumption can be transferred. The findings suggest that policy makers should support grassroots sustainability associations by making sure that they have access to niche places in which to carry out their projects and to learn from each other. Most of all, grassroots sustainability associations should be encouraged to keep creating alternative niche places and the members encouraged to continue to learn from each other in these places.

The findings add to the literature on skills for sustainable communities. Newton et al (2009) and Franklin et al (2011) have previously demonstrated the importance of understanding the roles of skills and knowledge for sustainable consumption in the context of place. This paper has demonstrated the importance of examining skills and knowledge for sustainable consumption in the context of place that is created and re-created by grassroots sustainability associations.

## References

- AGNEW, J. 1987. *Place and Politics*. Boston: Allen & Unwin.
- ALEXANDER, R., M. HOPE and M. DEGG. 2007. Mainstreaming Sustainable Development-A Case Study: Ashton Hayes is going Carbon Neutral. *Local Economy*, **22**(1), pp.62-74.
- BERKOWITZ, B. 1996. Personal and Community Sustainability. *American Journal of Community Psychology*, **24**(4), pp.441-459.
- CABLE, S. and M. BENSON. 1993. Acting Locally: Environmental Injustice and the Emergence of Grass-Roots Environmental Organizations. *Social Problems*, **40**(4), pp.464-77.
- CARLEY, M. and I. CHRISTIE. 2000. *Managing sustainable development*. UK and USA: Earthscan Publications Ltd.
- CRESSWELL, T. 2009. Place. In: N. THRIFT and R. KITCHEN, eds. *International Encyclopedia of Human Geography*. Amsterdam; London; Oxford: Elsevier, pp.169-77.
- ELGIN, D. 1993. *Voluntary Simplicity: Toward a way of life that is outwardly simple, inwardly rich*. Revised Edition ed. New York; London: Harper.
- ESCOBAR, A. 2001. Culture sits in places: reflections on globalism and subaltern strategies of localization. *Political Geography*, **20**(2), pp.139-74.
- FRANKLIN, A., NEWTON, J., MIDDLETON, J. AND MARSDEN, T. 2011. Reconnecting skills for sustainable consumption with everyday life. *Environment and Planning A*, **43**, pp.347-362.
- GREEN ACTION. 2011. Green Action Newsletter: Issue 1. Green Action.
- HARVEY, D. 2000. *Spaces of Hope*. Edinburgh: Edinburgh University Press.
- JACKSON, T. 2009. *Prosperity without growth: economics for a finite planet*. US & UK: Earthscan.
- LAVE, J. 1990. The Culture of Acquisition and the Practice of Understanding. In: J. W. STIGLER, R. A. SCHWEDER and G. H. HERDT, eds. *Cultural Psychology: Essays in Comparative and Human Development*. Cambridge: Cambridge University Press, p.309.
- MIDDLEMISS, L. 2009. *The role of community-based organisations in stimulating sustainability practices among participants*. PhD thesis. Leeds: University of Leeds.
- MIDDLEMISS, L. 2011. The power of community: how community-based organisations stimulate sustainable lifestyles among participants. *Society and Natural Resources*.
- NEWTON, J., A. FRANKLIN, J. MIDDLETON and T. MARSDEN. 2009. *Understanding the Role of Skills, Learning and Knowledge for Sustainable Communities*. Cardiff: BRASS.
- NEWTON, J., T. MARSDEN, A. FRANKLIN and A. COLLINS. 2008. *Supporting Skills and Knowledge to Deliver Sustainable Communities: An Exploration of the Conceptual and Policy Context*. Cardiff: BRASS.

- NORTH, P. 2010. Eco-localisation as a progressive response to peak oil and climate change – A sympathetic critique. *Geoforum*, **41**(4), pp.585-594.
- OPDM. 2004. *The Egan Review: Skills for Sustainable Communities*. London: The Stationary Office.
- PRED, A. 1984. Place as Historically Contingent Process: Structuration and the Time-Geography of Becoming Places. *Annals of the Association of American Geographers*, **74**(2), pp.279-97.
- REES, W. E. 2008. Human nature, eco-footprints and environmental injustice. *Local Environment*, **13**(8), pp.685-701.
- SEAMON, D. 1980. Body-subject, time-space routines, and place-ballets. In: A. BUTTIMER and D. SEAMON, eds. *The Human Experience of Space and Place*. New York: St. Martin's Press, pp.148-65.
- SEYFANG, G. 2009. *The new economics of sustainable consumption: Seeds of change*. Basingstoke: Palgrave Macmillan.
- SEYFANG, G. and A. SMITH. 2009. Grassroots Innovations for Sustainable Consumption. In: G. SEYFANG, ed. *The New Economics of Sustainable Consumption*. Basingstoke: Palgrave Macmillan, pp.63-82.
- SHOVE, E. 2010. Beyond the ABC: climate change policy and theories of social change. *Environment and Planning A*, **42**(6), pp.584-603.
- SMITH, D. H. 1997. Grassroots Associations are Important: Some Theory and a Review of the Impact Literature. *Nonprofit and Voluntary Sector Quarterly*, **26**(3), pp.269-306.
- SWYNGEDOUW, E. 2007. Impossible “sustainability” and the post-political condition. In: R. KRUEGER and D. GIBBS, eds. *Sustainable Development*. New York: Guildford Press.
- TUAN, Y. F. 1977. *Space and Place*. Minnesota: University of Minnesota.

**Living labs as a reflexive user-driven research infrastructure  
to promote sustainable consumption and production patterns:  
Experiences from exploratory research**

Paper for presentation at the 18th Annual International Sustainable Development Research Conference  
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**Abstract**

Humankind faces serious environmental and developmental challenges in the twenty-first century, such as climate change, resource scarcity and conflicts, rising energy generation and supply costs, diminishing access to clean water, poverty and drastic loss of biodiversity. In this context, sustainable consumption is widely regarded as a particularly suitable approach for addressing these issues in an integrated and systemic way: It is argued that a progressive transformation of consumption and production patterns is needed in order to live within environmental limits and to serve intra- and intergenerational justice. Participatory product development, especially the user integration in early stages of open innovation processes, and the broad diffusion of eco-innovation in value chains play an important role in this regard.

Against this background, the paper discusses the concept of the Sustainable LivingLab (SLL) as a reflexive user-driven research infrastructure for the development of technological and social innovations that promote more sustainable patterns of consumption and production. By integrating users and other relevant actors in the user's context at an early stage of the innovation process, better chances for the successful diffusion of innovations with lower life-cycle impacts can be expected. In this way, a SLL infrastructure helps fostering the adoption of eco-innovations by users, e.g. by supporting consumers to take advantage of their full resource and energy savings potentials. At the same time it is important to recognize unintended side effects can be recognized at an early stage of the development process. For example, potential negative rebound effects - starting at the level of individual consumption and technology use, following a centrifugal dynamic to encompass wider spheres of life, such as the neighbourhood, community, and the wider economy - should ideally be identified early. In order to do so, a SLL requires a reflexive approach and should consider more meso-level oriented approaches of transition management and global ecological limits.

The paper discusses and reflects results from ongoing applied sustainability research at the Wuppertal Institute, including explorative studies on how to set up SLLs at unit level and at

the level of a research infrastructure as well as networks that coordinate corresponding research activities at the national and international level.

## **1. Introduction**

Transforming value chains by developing new products or services, that successfully respond to the increasingly dynamic and complex requirements in society, is a key challenge for economic actors. These requirements are reflected in trends such as demographic change, climate change, resource scarcity and depletion, or more individualised lifestyles. In the last decades a large number of potentially sustainable product and service innovations have been brought to market, without large-scale integration of users during innovation processes, e.g. new models of supply, car sharing, new lighting systems or “just” less energy-consuming water boilers. However, these developments often do not perform in the intended way because of unexpected user behaviour (Liedtke et al. 2012a).

New pathways to responsible consumption and production are sought to meet these urging challenges and requirements. Education for sustainable consumption and promoting consumer citizenship are relevant preconditions for a change of direction (Welfens et al. 2010a). Overall, new social structures and processes in business and economy are required to enable sustainable consumption. How can sustainable product or service innovations be developed that do not show negative rebound effects in everyday use and at the same time increase user comfort and, thus, acceptance? This question is of high importance for transforming value chains towards more sustainable patterns of consumption and production. The average lifestyle of people in industrialised countries is characterised by high levels of consumption and is, thus, responsible for an enormous increase of resource extraction and environmental problems (Jackson 2005). Due to its high demands for energy and materials, housing is now considered one of the most important areas for a transition in consumption and production patterns (Spangenberg and Lorek 2002; Druckman et al. 2011).

In this paper we introduce Sustainable LivingLabs as a research approach that explicitly addresses sustainable consumption and production. The paper is subdivided into the following sections. Section 2 discusses the conceptualisation of LivingLabs, while section 3 introduces five research lines, comprising a research agenda for LivingLabs. Following this, in section 4 we outline current research activities at national and international level, employing the extended Sustainable LivingLab approach. This extended research infrastructure focuses on sustainability assessment along the entire value chain at different stages of the innovation process, thus aiming to shift consumption and production patterns towards resource efficiency and sustainable lifestyles. The conditions for a German SLL are explored based on interim findings of an ongoing research project with a German focus. In the last chapter, we resume the potentials of Sustainable LivingLabs and draw conclusions with regard to pathways to more sustainable value chains.

## **2. Conceptualising Sustainable LivingLab<sup>1</sup>**

Sustainable LivingLabs are an infrastructure to put users and other value chain related actors on centre stage in the innovation process and design of sustainable products or services, thereby reducing negative rebound effects through studying user-technology interactions in real-life settings (see Druckman et al. 2011). This way of integrating users in LivingLabs can provide an innovative way towards a more responsible lifestyle by changing structures and processes of developing sustainable products and services in industrial research. The in-depth study of everyday practices in domestic contexts and the drawing on evaluative feedback to

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<sup>1</sup> This section is mainly based on Liedtke et al. (2012c).

prototypes in real-life enables new processes for sustainable consumption. Even though some potential for resource efficiency lies in the fields of individual decision-making, behaviour and competence development (Green and Vergragt 2002), it should not only be put on the shoulders of individual consumers (Welfens et al. 2010b). Much more, changes in structures and processes in economy are needed, i.e. to use the potentials of open innovation processes. To this end Sustainable LivingLabs can contribute to necessary changes in society (i.e. opening of enterprises, integrating and activating essential stakeholder groups, enabling learning processes) by taking the next step in user-centred design. The research approach thereby aims to foster interactive and cooperative value chains (Schelske 2008; Walther 2010).

The Sustainable LivingLab is defined as an infrastructure designed to enable open innovation processes, in which users and other actors, relevant for the context, actively participate in development, testing and marketing, respectively of new products, services and system solutions. The interactive innovation process is situated in real life surroundings (living space, work environment, mobility, urban space). It is led by sustainability criteria and aims to contribute to global and universally applicable patterns of production and consumption (see Liedtke et al. 2012c).

The Sustainable LivingLab approach integrates several aspects of different research strands like consumption research as well as innovation, sustainability and transition research and recent developments in these fields (like theories of social practices, user integration, action research and sustainability assessment with focus on the entire value chain).

**Sustainability science** has accumulated considerable knowledge on tools and methods for sustainability assessments (see e.g. de Ridder, 2005; Clark et al. 2004). Also for assessing value chains, a number of methods and tools have been developed for different scopes and levels of data collection (site, company, supply chain, product, consumption) (e.g. Baedeker et al. 2005; Klöpffer and Renner 2007; Schaltegger et al. 2007; Project Group on the integration of social criteria into Life Cycle Assessment 2008; Geibler et al. 2010). However, these often show limitations as some of them do not consider the entire life-cycle (Baedeker et al., 2005). In addition, indirect effects are often not considered for analysis at the value chain level due to the limited knowledge on causal links (Geibler et al. 2010). For example, the supply of increasing market demand for one product might have effects on other markets, e.g. through psychological rebound effects (Paech 2005). The LivingLab approach addresses this problem by aiming to integrate the user as the most relevant expert (and cause of rebound effects) in the innovation process. In our continued research, the LivingLab approach has been extended in Germany, focussing sustainability assessment at different stages of the innovation process and resource efficiency (compare Three-Phases Model of Research in section 4).

**Innovation** processes underlie a tendency to get more and more opened up, integrating stakeholders, other businesses and end-users in the process of developing new products or services, already at early stages of development. Concepts like “open innovation”, brought into discussion by Chesbrough (2003), “wisdom of crowds” (Surowiecki 2004) or the “lead-user”-concept (von Hippel 1986) as well as the design of transformational products (Hassenzahl et al. 2011, Laschke et al. 2011), have recently promoted research in co-creation and led to a number of new business models and management tools to integrate users into innovation processes. Open innovation here means to make use of the purposive in- and outflow of knowledge across a company’s borders to accelerate internal innovation (Chesbrough 2006). Results show that these concepts can significantly reduce the risk for innovations to fail on the market, especially for radical innovations under uncertain market or technological conditions (Clausen et al. 2011: 35). Different methods of interaction have been developed, e.g. non-/ lead-Users involvement in innovation workshops for sustainability

innovations around the home (Diehl 2011) or web 2.0 tools to use collective intelligence (Leimeister 2010). However, open innovation research has so far seldom paid enough attention to the potentials for sustainability innovations.

**Changing routines** towards more environmentally responsible consumption patterns requires consumers to develop a consciousness for the social and ecological consequences of consumption practices (Ahaus, Heidbrink, Schmidt, 2011). However, research on the role of consumption for more sustainability revealed a gap between consumers' apparent knowledge about, for example, high ecological impacts of certain products, and acting according to that knowledge in everyday routines (Heidbrink, Schmidt, Ahaus, 2011). This gap at the consumer side limits the possibilities of establishing more responsible consumption patterns; it even increases the risk of negative rebound effects, which can potentially overcompensate for particular benefits. LivingLabs focus on the diffusion and user acceptance of sustainability innovations by involving users and other relevant actors along value chains into design processes (Heidecker et al. 2010).

Taking up the idea of open innovation and user-oriented design, our approach additionally draws on results of research in **systemic innovation** and social studies of technological development. Integrating the thesis of "co-evolution" of innovation trajectories (Rip and Kemp 1998), it can be concluded that sustainability innovations, which are meant to be successful in the long-term, can only be developed in an experimental and interactive setting (co-design). To involve users into research processes, the approach can also draw on insights from the methodology of action research (Lewin et al. 1953). Action research assumes that scientific findings can only be achieved if professional researchers take up concrete social problems in reality and actively involve 'laymen' into their research, in order to try and intervene in existing social structures. The LivingLab approach can be adapted flexibly according to a defined research design. Thus, users and stakeholders can be involved at all or at specific stages of research, i.e. in the phases of *defining a problem*, *designing a research strategy*, *creating results* or *application of results* (Talwar et al. 2011). The LivingLab infrastructure provides means to observe practices involving technical artefacts in the process of everyday use. The potentials of new prototypes to change current practices and, thereby, potentially change rules and resources of systems of provision bottom-up, can be analysed in real-life settings. Social practices in using the new product have to be regarded during the innovation process, since all too often products designed for environmental efficiency under given circumstances are misused or overused, resulting in unintended and generally less sustainable outcomes ('the rebound effect') (Liedtke et al. 2012b).

**Transition research** studies complex socio-technical change processes to meet challenges of sustainable development, aiming to identify underlying patterns and dynamics (Geels and Schot 2007). A multilevel perspective on change as an interplay of developments on the three functional levels 'landscape', 'regime' and 'niche' is in the centre. Transition means a deep change of 'regime' of a specific system. 'Regime' here refers to the currently predominant structure of a social system in terms of culture, dominant values and patterns of action. A process of change in material infrastructures, organisational structures, values and norms to establish new patterns of perception and action (transition) can be induced by combining several different developments (Kemp and Loorbach 2006). To describe such complex processes of change the Circular Transition Model was developed, which distinguishes the phases of Problem Assessment, Vision Development, Experiments and Learning & Upscaling (Loorbach 2010). At the Wuppertal Institute transition research is established as a meta-approach for the institute's research and development in sustainability (Schneidewind et al. 2011). The phases of Experiments and Learning & Upscaling can especially well be conducted within the Sustainable LivingLab infrastructure. The methods employed in the

research infrastructure, as we will describe in the following section, can serve as an example for these parts of the circular model.

### **3. Five Research Lines for a LivingLab research agenda<sup>2</sup>**

Focussing on sustainable homes and related value chains, Product-Service-Systems or Sustainable Consumption-Production-Systems, Sustainable LivingLabs can help to identify new ways in one of the most crucial areas for reducing resource extraction and environmental impact (Rohn et al. 2011). Actually, modern sustainable homes are often rather high-tech environments. Home occupants have to monitor, manage, maintain and live with complex technology interfaces, connecting and interacting with heating, cooling, ventilation, lighting, communication, and energy management systems of the home. Thus, it is one of the key challenges to find out to what extent people can indeed successfully interact with this potentially complex range of systems. Furthermore, it is to be explored in how far this interaction leads to more sustainable households over time along five generic research lines (Welfens et al. 2010b).

Initially, the LivingLab infrastructure including the methodology and research lines was developed and implemented in a design study within the 7th Framework Programme of the European Union (2008-2010), conducted in a cooperative project by four academic (led by TU Delft in cooperation with ETH Zurich, Universidad Politecnica de Madrid, Wuppertal Institute) and three industrial partners (ACCIONA, BASF, Procter & Gamble). It aimed at understanding why sustainable technologies that seem technologically and behaviourally adequate, and despite people's willingness to act for sustainability, often do not perform in the intended way in real life. The research infrastructure concentrated on human-technology interactions, acceptance and adoption of sustainability innovations focused around the home, such as ventilation, water and energy management. Its basic assumption was that, in order to research user acceptance and rebound effects, human-technology interaction must be understood within the context of everyday practices of utilisation (Bakker et al. 2010).

Within the Design Study five research lines were defined based on a foresight process analysing and evaluating global megatrends. An expert panel of the LivingLab consortium ranked these megatrends in order of their relevance for sustainability and the LivingLab approach. The trends were chosen in terms of how they affect innovation intensity, competitiveness and user orientation. Employing a cross-impact analysis of the most relevant megatrends and basic functions of homes, important research questions and topics were elaborated. These again were summarized to five research lines, helping to structure the potentially broad scope of the LivingLab infrastructure. These five generic research lines are (Welfens et al. 2010b; Liedtke et al. 2012b):

#### *Design, construction and maintenance of sustainable homes*

LivingLab facilities are highly visible examples at the frontier of sustainable building systems for reducing emissions, material consumption, energy and water use. This research line is thus close to the primary idea of LivingLab, founded at the MIT, and focuses the collaborative development and testing of i.e. easy to install and user-friendly systems or materials that can easily be dismantled, separated or reused. Another focus is on implementing feedback loops between actors and decision makers in planning and construction.

#### *Integrated approaches to home energy management*

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<sup>2</sup> This section is mainly based on Liedtke et al. (2012c).



Sustainable LivingLab offers a unique opportunity to study the integration of demand-based energy offerings and related services in combination with smart appliances and low-energy heating and lighting solutions. For the purpose of this paper, this research line serves as a case study (compare below). The focus here is on developing interaction designs and smart systems (smart meters, smart grids) that can encourage and support inhabitants in saving resources, whereas complex control technologies become an integral part of such systems. Therefore, the Sustainable LivingLab infrastructure can provide an opportunity to study user-technology interactions. Working prototypes should be placed in a real-world context, involving actual consumers. Research questions mainly consider:

1. The physical design of the product, including perceived physical affordances, ease of use, and pleasure in use.
2. Social interaction issues, including perceived social norms, i.e. how much energy does a comparable household in a similarly sized house consume?
3. The perceived environment as recognized by the energy savings system, including issues like the amount of daylight, outdoor temperature, or detected user activities.
4. Financial and environmental incentives for indicating at what time of the day there is a grid surplus of green energy.

#### *The connected home*

Rising virtual services such as tele-working, tele-shopping or social connectedness in the web 2.0 have a potential to radically change habits, develop new markets and increase resource efficiency at the same time. This indicates the need to extend the scope of LivingLab research questions also on activities beyond the home, since implications of this on-going virtualisation of working, social interaction and consumption should be considered.

#### *Resource-efficient lifestyles and social networks*

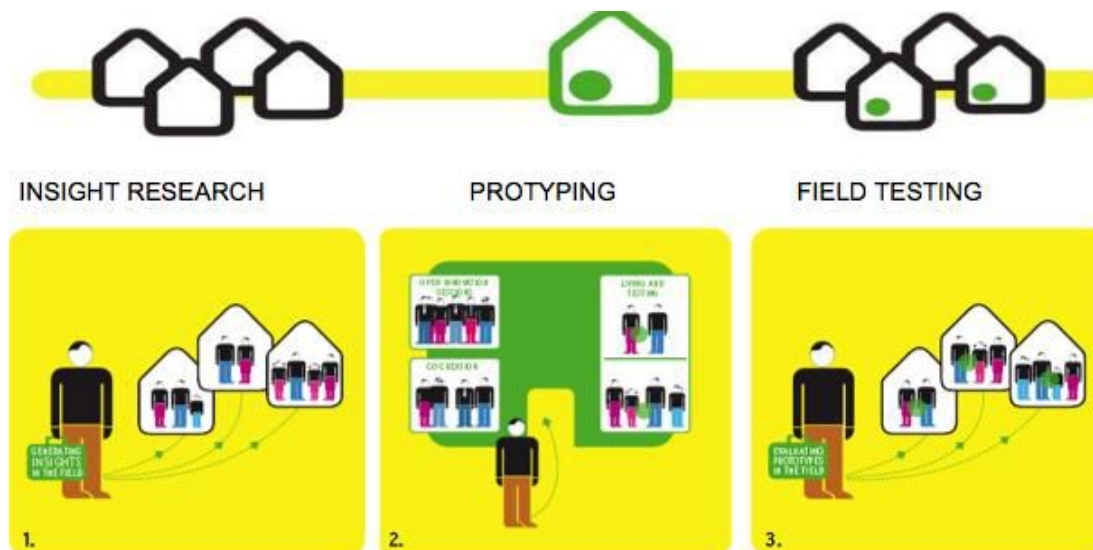
In connection to the last research line, the Sustainable LivingLab approach offers the possibility to study lifestyles and consumption patterns in a real-world setting. The role of user's motivations and pleasure in interdependence with socially constituted ways of using a certain product or service, forming social practices of consumption, can be studied. Even within relatively homogeneous groups of users (in terms of age, education and socio-economic situation), studies have shown that varying consumption patterns can lead to vast differences in the amount of energy and resources used by households (e.g. Kotakorpi et al. 2008). Furthermore, the impact of training sessions for end consumers and awareness tools (such as smart meters) can be analysed. Do users change their actions in result, does this achieve energy savings, and how can tools be improved, i.e. in terms of visualisation with colours, graphs or figures?

#### *New product and service development*

“Products with significant environmental effects in the use phase should be developed in LivingLab with a clear focus on the user context to prevent unwanted side effects” (Liedtke et al. 2012b: 12). Trends, such as the increasing percentage of electronic devices at home or the growing trend to work at home offer a seemingly endless range of possibilities to create new sustainable practices around them, especially at this early stage.

### **4. Developing a Research Infrastructure and Methodology for Sustainable LivingLabs**

In the initial Design Study, a three-phases model of research was developed under the lead of TU Delft, which served as a conceptual framework of methods to conduct innovation processes in LivingLabs (see Figure 1).



**Figure 1: Three-Tier Model of Research in the LivingLab Design Study (Bakker et al. 2010: 11)**

In the first tier “Insight Research”, human needs were to be analysed within their everyday context, i.e. their own homes, while in the second tier “Prototyping” new products or services were tested within the LivingLab dwellings. On this basis, prototypes were (re)designed and then tested in the field in the third tier (Bakker et al. 2010).

In relation to the management of interactive value-added processes (Schelske 2008; Reichwald and Piller 2006; Walther 2010) the Research Group 4 “Sustainable Production and Consumption” at the Wuppertal Institute extended this methodology for user-integrated design of products or services. The objective is to early identify trends in the field of Sustainable Consumption and Production and integrate all relevant actors in value chains (producers, handicraft, consumers, users, consultants etc.) directly into the development of research strategies and product design – thereby, focussing on resource efficiency and sustainable lifestyles as well as basic innovations with an increased demand for change. Besides developing resource-efficient technologies and product-service systems (Rohn et al. 2011), main emphasis is put on contributing to a culture of more resource efficiency in economy and lifestyles (Low Resource and Carbon Society). Furthermore, requirements for change in value chains and their management are to be derived.

The research objectives followed are to analyse relationships between home occupants’ behaviour, domestic resource consumption and domestic systems (products, technologies or infrastructures, i.e. mobility), with the aim of minimising resource consumption and waste production, while still optimising users’ experience and comfort. Participating households test the obtained solutions, before the other value chain related actors are involved in stakeholder dialogues on new prototypes.

Currently, the Wuppertal Institute is cooperating in two research projects at national and international level, which build on the initial Design Study and further develop the LivingLab idea for sustainability innovations with special focus on sustainable lifestyles and resource efficiency. Interim results are presented below.

### **Exploring potentials of a German infrastructure for Sustainable LivingLabs**

The Wuppertal Institute is currently conducting a research project in cooperation with Fraunhofer IAO, Fraunhofer ISI and Faktor 10 – Institute on “Sustainability Innovations in LivingLabs”, funded by the German Federal Ministry of Education and Research (2011-2012). This project focuses on Germany and a specific national infrastructure for Sustainable LivingLabs. Main research questions included are: In which fields can LivingLab be expected

to gain a high potential for sustainability innovations? What should a German research infrastructure look like in contrast to the European design study, if these potentials are to be engaged? What are suitable starting points for such an interactive setting in the existing German Research and Development landscape? What are fields of application (technologies, products, services) where Sustainable LivingLabs can offer a high potential for sustainability innovations. Also, a dialogue between relevant actors is part of the project.<sup>3</sup>

Within the project, the German research and development (R&D) landscape is screened. Thereby, suitable starting points for interactive and systematic research on product and service use in domestic and workplace environments and their sustainability implications are analysed. The aim is to create a profile of the corresponding status quo. Interim results of the project, highlight that the existing German research and development (R&D) landscape is scattered and heterogeneous with respect to a potential SLL infrastructure. On the one hand there are just a few institutionalised infrastructures in place, such as the Fraunhofer-inHaus-Center, set up by the Fraunhofer-Gesellschaft. Fraunhofer-inHaus combines the potential of seven Fraunhofer Institutes and around 100 partners from industry with the objective to develop, test and demonstrate new solutions for rooms and buildings, and bring them to market. On the other hand, there are various project-based living lab initiatives, such as the “Neighborhood Lab” of the Design Research Lab at the University of the Arts Berlin. In both types of LL sustainability and especially ecological aspects are not considered intensively. Consequently, there is a need to support and develop a research infrastructure for SLL.

With respect to the potential fields of application the results confirm the research lines identified in the European Design Study. Findings show a demand for different types of living labs, depending on the area of application: Living labs for homes, retail living lab as well as regional living labs. In each area of application, a number of products and services could be identified with resource efficiency. In order to develop a German research infrastructure, however, several challenges have to be met. A number of barriers could be identified within the project (table 1). The ongoing project will further refine these results and explore strategies how to overcome these barriers.

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<sup>3</sup> For more information on the project see:  
[http://www.wupperinst.org/en/projects/proj/index.html?projekt\\_id=398&bid=139](http://www.wupperinst.org/en/projects/proj/index.html?projekt_id=398&bid=139)

**Table 1: Barriers for a German SLL Infrastructure (Geibler et al. 2012)**

<b>Barriers</b>	<b>Description</b>
Limited long-term funding	Project-based funding can make it difficult to pursue cross-cutting sustainability aspects over the medium to long run.
Bureaucracy in funding organisations	Funding organisations work according to the logic of good housekeeping – which might not always be appropriate for pursuing the logics of sustainability and innovation.
Lack of methods and standards	There is a lack of suitable methodological standards for the evaluation of sustainability. “Sustainability” can usually only be evaluated on the basis of aggregated data. On the micro-level of living labs alone it can be difficult to evaluate the aggregated sustainability effects of innovations (e.g. because of rebounds and networks effects). Existing methods of sustainability evaluations only cover partial aspects, e.g. resource efficiency.
Limited appreciation of acceptance research	Research into technology acceptance does not receive sufficient appreciation. Often producers are rather focused on technical functionality.
Short-term perspective of companies	The logic of companies and business development associations is too much driven by profitability in order to systematically integrate sustainability. The time horizon of companies is often too short for dealing comprehensively with sustainability problems. Companies may tend to integrate users only superficially in development processes when they already have preferred solutions “in the drawer”. There is the danger that firms might not want to pay for independent research but rather expect advertisement for their own products.
Fear of transparency / privacy issues	Companies may shy away from transparency requirements, as they dislike the prospect of receiving bad publicity when their products or services are compared to those of competitors. Without sufficient incentive users may not be willing to accept infringements on their privacy. It can be challenging to motivate users for longer periods of time.
Divergent expectation of involved actors and competition	Companies and users have divergent temporal horizons: While users want improvements straight away, firms may only want to test their novel solutions at specific points in time. Furthermore, user-groups can be very heterogeneous and thus may not always be representative for the wider population. Competition among firms and research institutes alike can make cooperation difficult. Technological competition can be a hindrance to open innovations processes. As the innovation process is open, the optimal partners cannot be known at the beginning of a project, but involving new partners is often difficult.
Communication barriers:	Researchers, users and companies speak “different languages”. There is a lack of mediators between “soft” factors such as user-integration and scientists engaged with “hard” technologies. Mediation can also lead to information losses.

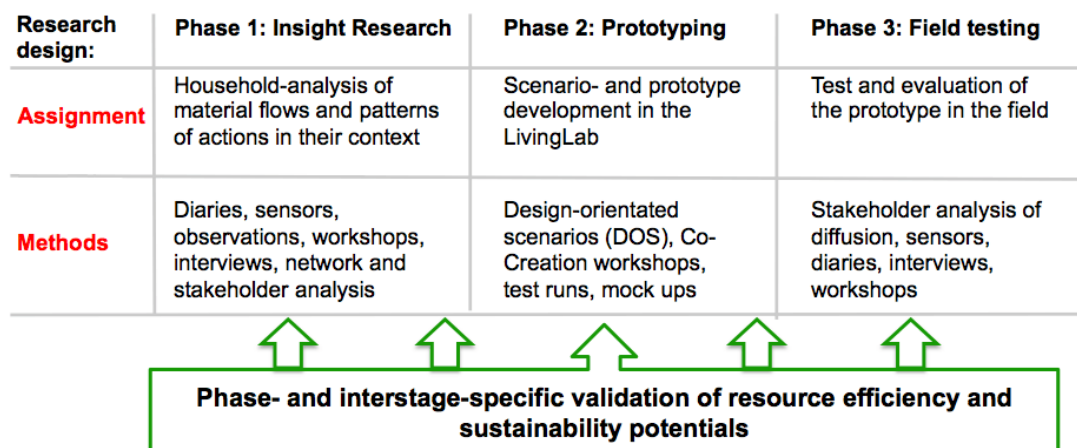
### Exploring research models for Sustainable LivingLabs in a case study<sup>4</sup>

The project “SusLabNWE - Creation of a networked infrastructure for innovation on sustainability in the home environment that enables user-centred testing and development in living laboratories” is conducted in a joint-project of research facilities and stakeholder partners across Europe (2012-2015), funded by the European Regional Development Fund (ERDF), Programme INTERREG IVB NWE. It aims to set up a networked infrastructure of houses and LivingLabs in North-West Europe at five locations: Rotterdam (NL), Ruhr area (DE), London (UK), Gothenburg (SE) and Zurich (CH). Each location will be set-up according to the results of the Design Study on LivingLabs and run in public-private partnership. Companies, researchers and policymakers will be able to collaborate in these

<sup>4</sup> This section is mainly based on Liedtke et al. (2012c).

multi-disciplinary, user-centred testing facilities in order to increase household's sustainability.<sup>5</sup>

The focus area of the German consortium within the SusLabNWE Project<sup>6</sup> (Wuppertal Institute, Hochschule Ruhr West and InnovationCity Management GmbH) is located in the Ruhr area in North Rhine-Westphalia. Several districts of the city of Bottrop, all together an area with approximately 67,000 inhabitants, have been nominated as the model region 'InnovationCity Ruhr'<sup>7</sup>, and is as such participating as one of the five locations in the SusLabNWE project. Different initiatives aim to reduce CO<sub>2</sub>-emissions by 51 % until 2020. In the field of heating alone a cut of consumption from 829 GWh now to 409 GWh in 2020 is aspired. The project – co-financed by the Ministry of Innovation, Science and Research of the German Federal State North Rhine-Westphalia – aims at building up a LivingLab infrastructure here and, thus, contributing to this ambitious transition process by setting up a pilot application in the area of heating and cooling in InnovationCity Ruhr. Approximately 80% of all heating systems in Germany work inefficiently and consume too much energy. Combined with optimising user behaviour, savings of 10-30% of heating energy are possible (Messerschmidt 2012). The following Figure 2. gives an outline of how the Three-Phases Model of research is adopted and employed in the SusLabNWE project.



**Figure 2: The Three-Phase Model of Research in Sustainable LivingLabs (Liedtke, Geibler and Greiff, based on Green and Vergragt 2002; Bakker et al. 2010)**

**First Phase - Insight Research:** Point of departure is an in-depth analysis of material flows and patterns of action within households. For InnovationCity Ruhr, user behaviour will be analysed in 20-50 households of the area using qualitative and quantitative research methods, and focussing on heating. Methods include i.e. qualitative interviews or installing temporary data loggers for temperature and air quality in the households. A network and stakeholder analysis on who are relevant actors in the heating system for the area, as well as workshops with producers on heating 2.0 will be conducted. This research will be conducted in the real-life environment of people's homes, thus it is possible to scrutinise the household's consumption and patterns of action in their actual context.

**Second Phase - Prototyping:** In this second phase the actual testing in the Sustainable LivingLab infrastructure is carried out. Lead-user and non-lead-user groups will be identified

<sup>5</sup> For more information on the overall project: [http://www.nweurope.eu/index.php?act=project\\_detail&id=4203](http://www.nweurope.eu/index.php?act=project_detail&id=4203)

<sup>6</sup> For more information on the German project:  
[http://www.wupperinst.org/projekte/proj/index.html?projekt\\_id=426&bid=29](http://www.wupperinst.org/projekte/proj/index.html?projekt_id=426&bid=29)

<sup>7</sup> <http://www.bottrop.de/microsite/ic/>

and open innovation and co-creation workshops will be performed by Fraunhofer inHaus, an existing research facility in the area and capable for the LivingLab infrastructure. Development of design-oriented scenarios, test runs with new prototypes as well as user-integration with mock ups in Fraunhofer inHaus are focus areas to employ the Sustainable LivingLab infrastructure within the research project. Furthermore, qualification tools and materials with a focus on the interaction of actors along the whole value chain of heating will be developed.

**Third Phase - Field Testing:** As a third step in the research process, fully functional prototypes will be tested and evaluated in the field, installing them in existing or newly built homes. Similar to the first phase, another stakeholder analysis of the diffusion for the newly developed prototype can be conducted as well as further in-depth tests in terms of sensoric observations. Again, quantitative methods, i.e. measuring potentials for energy savings, and qualitative research methods like interviewing users and stakeholders along the value chain can be combined.

During the development process a phase- and interstage-specific validation of resource efficiency and sustainability potentials of the new prototype is performed. By these means, sustainability assessment along the value chain is integrated throughout the Sustainable LivingLab approach. By doing so, necessary re-adjustments can be done at any stage of the open innovation process. At these stage, however, differences in data availability for a new prototype have to be regarded when conducting sustainability assessments. Especially for second order effects (technology application), data availability is more limited in the beginning of an innovation process since applications of developed products or services might only become apparent in the future (Geibler et al. 2006). Throughout the research process, time for reflection and learning processes is provided, thus, supporting future developments in the LivingLab's infrastructure in the sense of learning loops.

## 6. Conclusions

In this paper we have described a Sustainable LivingLab research infrastructure as a means to put users on centre stage in the innovation process of new sustainable products, services or models of supply. The Sustainable LivingLab approach enables design and development in such a way that user behaviour and social practices can be aligned with technological aspects for a more sustainable consumption and more sustainable value chains. By actively involving users and other important stakeholders in the innovation process, the potentials of diverse perspectives can be used and observing the practical application of innovations becomes possible. By these means, Sustainable LivingLabs can contribute to a necessary change in structures and processes both bottom-up (by sustainability innovations showing high user acceptance and less rebound effects) as well as top-down, e.g. by inducing a change in existing patterns of innovation and structures of energy supply. Developing a research infrastructure based on SLL will be challenging, as the case study in Germany and identified barriers highlight. There is a need to further explore the potentials and pathways for a Sustainable LivingLab infrastructure, both for companies that can benefit from more successful innovations and society that can benefit from more sustainable innovations and increased resource efficiency. Collaboration for sustainable consumption can be found in the collaboration of different stakeholder groups and users in innovation processes of new products or services. Overcoming key barriers and institutionalising this form of innovation process is likely to contribute to sustainable development.

## References

- Ahaus, B. Heidbrink, L. Schmidt, I., 2011. *Der verantwortliche Konsument. Wie Verbraucher mehr Verantwortung für ihren Alltagskonsum übernehmen können*. Working Paper No. 10/2011 of the Centre for Responsibility Research at KWI, Essen.
- Baedeker, C.; Liedtke, C.; Welfens, J.; Busch, T. et al., 2005. *Analyse vorhandener Konzepte zur Messung des nachhaltigen Konsums in Deutschland einschließlich der Grundzüge eines Entwicklungskonzeptes*. Project report. Wuppertal Institute, Wuppertal.
- Bakker, C. et al., 2010. *LivingLab: Summary Report*. forthcoming.
- Barbier, E.B., 2009. *A Global New Deal*. Report prepared for the Economics and Trade Branch, Division of Technology, Industry and Economics, UNEP. Laramie: University of Wyoming.
- Bourdieu, P., 1977. *Outline of a Theory of Practice*. Cambridge: Cambridge University Press.
- Bourdieu, P., 1979. *Distinction: A Social Critique of the Judgement of Taste*. London: Routledge.
- Brand, K. W., 2010. Social Practices and Sustainable Consumption: Benefits and Limitations of a New Theoretical Approach. In: M. Gross and H. Heinrichs, eds. *Environmental Sociology: European Perspectives and Interdisciplinary Challenges*. Dordrecht/Heidelberg/London/New York: Springer, pp. 217-234.
- Chesbrough, H.W., 2003. *Open Innovation: the new imperative for creating and profiting from technology*. Boston: Harvard Business School Publishing.
- Chesbrough, H.W., 2006. Open Innovation: A New Paradigm for Understanding Industrial Innovation. In: H.W. Chesbrough, W. Vanhaverbeke and J. West, eds. *Open Innovation: Researching a new paradigm*. New York: Oxford University Press, pp. 1-14.
- Clark, W. C. Crutzen, P. J. and Schellnhuber, H. J., 2004. Science for global sustainability. In: Schellnhuber, H. J. et al., eds. *Earth system analysis for sustainability. Dahlem Workshop Report 91*. Cambridge: MIT Press, pp. 1-28.
- Clausen, J. Fichter, K. and Winter, W., 2011. *Theoretische Grundlagen für die Erklärung von Diffusionsverläufen von Nachhaltigkeitsinnovationen*. Borderstep Institut für Innovation und Nachhaltigkeit, Berlin.
- de Ridder, W., 2005, *SustainabilityA-Test Inception report*. Report no 555000001 from the Netherlands Environmental Assessment Agency. Available at: <http://www.rivm.nl/bibliotheek/rapporten/555000001.pdf> (last access 29 May 2012).
- Diehl, B., 2011. Nachhaltigkeitsinnovationen im Bedarfsfeld Wohnen. In: F.M. Belz, U. Schrader and M. Arnold, eds. *Nachhaltigkeitsinnovationen durch Nutzerintegration*. Marburg: Metropolis, pp. 121-144.
- Druckman, A. Chitnis, M. Sorell, S. and Jackson, T., 2011. Missing carbon reductions? Exploring rebound and backfire effects in UK households. In: *Energy Policy*, 39(6), pp. 3572-3581.
- ETC/SCP, 2009. *Environmental Pressure from European Consumption and Production*. ETC/SCP Working Paper 1/2009, European Centre on Sustainable Consumption and Production. Copenhagen.
- Geels, F.W. and Schot J.W., 2007. Typology of sociotechnical transition pathways. *Research Policy*, 36(3), pp. 399-417.
- Geibler et al. (2012): Ergebnisbericht im Projekt „Nachhaltigkeitsinnovationen im LivingLab. Ergebnisse der „Analysen zu Umsetzungsbedingungen“, Arbeitsschritt 2.2 des Arbeitspaketes 2.2: „Potenzialanalyse von Nachhaltigkeitsinnovationen durch LivingLabs“. Forthcoming.

- Geibler, J.v. Kristof, K. and Bienge, K., 2010. Sustainability assessment of entire forest value chains: Integrating stakeholder perspectives and indicators in decision support tools. In: *Ecological Modelling*, 221(18), pp. 2206-2214.
- Geibler, J.v. Liedtke, C. Wallbaum, H. and Schaller, S., 2006. Accounting for the social dimension of sustainability. Experiences from the biotechnology industry. In: *Business Strategy and the Environment*. Special Issue *Sustainability Accounting*, 15(5), pp. 334-346.
- Giddens, A., 1984. *The Constitution of Society: outline of the Theory of Structuration*. Berkeley/Los Angeles: University of California Press.
- Green, K. and Vergragt, P., 2002. Towards sustainable households: a methodology for developing sustainable technological and social innovations. In: *Futures*, 34(5), pp. 381-400.
- Hassenzahl, M. Prinz, W. Buchholz, H. and Laschke, M., 2011. Zwischen Können und Tun liegt ein großes Meer und auf seinem Grunde die gescheiterte Willenskraft. In: *i-com*, 10(2), pp. 1-2.
- Heidbrink, L. Schmidt, I. Ahaus, B., eds., 2011. *Die Verantwortung des Konsumenten. Über das Verhältnis von Markt, Moral und Konsum*, Frankfurt/New York: Campus.
- Heidecker, S. Diefenbach, S. Creutz, P. Laschke, M. and Hassenzahl, M., 2010. Transformationale Produkte: Erleben und wahrgenommene Veränderungspotentiale. In: J. Ziegler and A. Schmidt, eds. *Mensch & Computer 2010. Interaktive Kulturen*. München: Oldenbourg Verlag, pp. 195-204.
- Jackson, T., 2005. *Motivating Sustainable Consumption. A Review of Evidence on Consumer Behavior and Behavioral Change. Report to the Sustainable Development Network*. Available at: <https://www.c2p2online.com/documents/MotivatingSC.pdf> (last access 29 May 2012).
- Kemp, R. and Loorbach, D., 2006. Transition management: a reflexive governance approach. In: J.-P. Voss D. Bauknecht and R. Kemp, eds. *Reflexive Governance for Sustainable Development*. Cheltenham: Edward Elgar, pp. 103-130.
- Klöpffer, W. and Renner, I., 2007. Lebenszyklusbasierte Nachhaltigkeitsbewertung von Produkten. In: *Technikfolgenabschätzung - Theorie und Praxis* 16(3), pp. 32-38.
- Kotakorpi, E. Lähteenoja, S and Lettenmeier, M., 2008. *Household MIPS: natural resource consumption of Finnish households and its reduction*. The Finnish Environment 43en/2008. Ministry of Environment, Environmental Protection Department, Helsinki.
- Laschke, M. Hassenzahl, M. and Diefenbach, S., 2011. *Things with attitude: Transformational Products*. Create11 Conference (pp. 1-2), [online] Available at: <http://www.create-conference.org/storage/create11papersposters/Things with attitude.pdf> (last access 29 May 2012).
- Leimeister, J.M., 2010. Collective Intelligence. In: *Business and Information Systems Engineering*, 4/2010, pp. 245-248.
- Lewin, K. Lewin, G.W. and Frenzel, H.A., 1953. *Die Lösung sozialer Konflikte*. Bad Nauheim: Christian.
- Liedtke, C. et al., 2012a. *LivingLabs zur Integration von Nutzerverhalten und Nachhaltigkeit im Innovationsprozess*. Forthcoming.
- Liedtke, C. Welfens, M.J. Rohn, H. and Nordmann, J., 2012b. Living Lab: User-Driven Innovation for Sustainability. In: *International Journal of Sustainability in Higher Education*, 13 (2), pp. 106 - 118.



- Liedtke, C., Baedeker, C., Geibler, G.v.; Hasselkuß, M., 2012c. User-integrated Innovation: Sustainable LivingLabs Research and development of sustainable products and services through user-driven innovation. Paper presented at PERL International Conference “Beyond Consumption: Pathways to Responsible Living”, 19-20 March 2012 at the Technical University of Berlin, Germany.
- Loorbach, D., 2010. Transition Management for Sustainable Development: A Prescriptive, Complexity-Based Governance Framework. In: *Governance: An International Journal of Policy, Administration and Institutions*, 23(1), pp. 161-183.
- Mancini, L., Lettenmeier, M. Rohn, H. and Liedtke, C., 2011: Application of the MIPS Method for assessing the sustainability of production-consumption systems of food. In: *Journal of Economic Behavior & Organization, GDP to Well-being Special Issue*, 81(3), pp. 779–793.
- Messerschmidt, J., 2012. Smart Submetering für die Wohnungswirtschaft: Niedrig-intensive Maßnahmen zur Energieverbruachssenkung bei Gebäuden. In: *Energy 2.0 Kompendium 2012*, p. 99.
- Paech, N., 2005. Richtungssicherheit im nachhaltigkeitsorientierten Innovationsmanagement. In: Fichter, K. Paech, N. and Pfriem, R., eds. *Nachhaltige Zukunftsmärkte. Orientierungen für unternehmerische Innovationsprozesse im 21. Jahrhundert*. Marburg: Metropolis, pp. 323-347.
- Piller, F. Wagner, P. and Antons, D., 2012. Innovationsmanagement in der Energiebranche - Anwendung des Open Innovation-Ansatzes. In: H.-G. Servatius, U. Schneidewind and D. Rohlfing, eds. *Smart Energy: Wandel zu einem nachhaltigen Energiesystem*. Heidelberg/Dordrecht/London/New York: Springer, pp. 173-192.
- Project Group on the integration of social criteria into Life Cycle Assessment, 2008. *Code of Practice for a social-economical LCA (seLCA) for product assessment*. UNEP / SETAC Life Cycle Initiative. United Nations Environment Programme.
- Reckwitz A., 2002. Toward a Theory of Social Practices. *European Journal of Sociology*, 5/2002, pp. 243-263.
- Reichwald, R. and Piller, F., 2006. *Interaktive Wertschöpfung: Open Innovation, Individualisierung und neue Formen der Arbeitsteilung*. Wiesbaden: Gabler.
- Rip, A. and Kemp, R., 1998. Technological Change. In: S. Rayner and E.L. Malone, eds. *Human Choice and Climate Change. Two: Resources and Technology*. Columbus: Batelle Press, pp. 327-399.
- Rohn, H. Lettenmeier, M. and Pastewski, N., 2011. Identification of Technologies, Products and Strategies with High Resource Efficiency Potential: Results of a Cooperative Selection Process. In: R. Bleischwitz P.J.J. Welfens and Z. Zhang, eds. *International Economics of Resource Efficiency*. Heidelberg: Physica-Verlag HD, pp.335-347.
- Rohn, H., 2011. Ressourcenkultur: Untersuchung von Ressourceneffizienzinnovationen und Vertrauenskulturen in KMU als Beitrag für eine nachhaltige Entwicklung. In: K. Möslin et al. (eds). *Arbeit in Balance: flexibel, stabil, innovativ. Strategien für das 21. Jahrhundert*. Nürnberg: Institut für Wirtschaftsinformatik, pp. 12-13.
- Röpke I., 2009. Theories of practice: New inspiration for ecological economic studies on consumption. *Ecological Economics*, 68(10), pp. 2490-2497.
- Schaltegger, S.; Herzig, C.; Kleiber, O.; Klinke, T.; Müller J., 2007. *Nachhaltigkeitsmanagement in Unternehmen: Von der Idee zur Praxis*. Berlin and Lüneburg: BMU, econsense and CSM.

- Schelske, A., 2008. Transparente Märkte in interaktiven Wertschöpfungsprozessen. Synchroner Konsumforschung mit vernetzten Konsumenten. In: D. Schrage & M. R. Friederici, eds. *Zwischen Methodenpluralismus und Datenhandel. Zur Soziologie der kommerziellen Konsumforschung*. Wiesbaden: VS Verlag, pp. 167-191.
- Schneidewind, U.; Scheck, H.; Augenstein, K.; Baedeker, C.; Beuermann, C. et al., 2011. *Transitions towards Sustainability: Rethinking the Wuppertal Institute Research Perspective*. Internal Working Paper. Wuppertal Institute, Wuppertal.
- Spaargaren, G. Martens, S. and Beckers, T.A.M., 2006. Sustainable Technologies and Everyday Life. In: P.-P. Verbeek and A. Slob, eds. *User Behavior and Technology Development: Shaping Sustainable Relations Between Consumers and Technologies*. Dordrecht: Springer, pp. 107-118.
- Spaargaren, G., 2011. Theories of practice: Agency, technology, and culture. Exploring the relevance of practice theories for the governance of sustainable consumption practices in the new world-order. *Global Environmental Change*, 21, pp. 813-822.
- Spangenberg, J.H. and Lorek, S., 2002. Environmentally sustainable household consumption: from aggregate environmental pressures to priority fields of action. *Ecological Economics*, 43 (2-3), pp. 127-140.
- Surowiecki, J., 2004. *The Wisdom of Crowds: Why the Many are Smarter than the Few and How Collective Wisdoms Shapes Businesses, Economies, Societies and Nations*. New York: Doubleday and Company.
- Talwar, S. Wiek, A. and Robinson, J., 2011. User engagement in sustainability research. In: *Science and Public Policy*, 38 (5), pp. 379-390
- von Hippel, E., 1986. Lead Users: A Source of Novel Product Concepts. *Management Science*, 32(7), pp. 791-805.
- Walther, G., 2010. *Nachhaltige Wertschöpfungsnetzwerke. Überbetriebliche Planung und Steuerung von Stoffströmen entlang des Produktlebenszyklus*. Wiesbaden: Gabler.
- Warde, A., 2005. Consumption and Theories of Practice. *Journal of Consumer Culture*, 5(2), pp. 131-153.
- Welfens, M. J. Liedtke, C. and Nordman, J., 2010a. *Sustainable consumption: between unsustainable reality and people's willingness to act*. Paper presented at the ERSCP-EMSU Conference "Knowledge Collaboration & Learning for Sustainable Innovation", Delft, The Netherlands, October 25-29, 2010.
- Welfens, M.J. Liedtke, C. Rohn, H. and Nordmann, J., 2010b. *Living Lab: Research and Development of Sustainable Products and Services Through User-Driven Innovation in Experimental-Oriented Environments*. Paper presented at the ERSCP-EMSU Conference "Knowledge Collaboration & Learning for Sustainable Innovation", Delft, The Netherlands, October 25-29, 2010.

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**Utilising Systems Mapping for Understanding the Contradictions  
of Sustainable Consumption and Economic Growth**

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**Abstract**

The paper aims to present how the usage of systems thinking, in particular as participatory construction of causal loop diagrams (CLDs), can contribute to a systemic understanding of sustainable consumption. In the framework of an FP7 project titled RESPONDER we are testing the usage of CLDs for knowledge brokerage. Building on participatory modelling approaches and applications we developed a method of ‘participatory systems mapping’ (PSM) in which CLDs serve as boundary objects and enable co-creation of knowledge. The paper describes how engaging with CLDs can produce specific types of insights that together support a systemic, complex and multi-perspectival understanding of a given problem and thereby can effectively foster learning and help formulation of effective policies for sustainability.

**Keywords**

sustainable consumption, economic growth, knowledge brokerage, systems thinking, causal loop diagrams, participatory systems mapping

## 1 Introduction

When the Brundtland report popularised the concept of ‘sustainable development’ in 1987, it also emphasised the need for developing more sustainable consumption patterns: “Sustainable development requires that those who are more affluent adopt lifestyles within the planet’s ecological means” (WCED, 1987: 9). The commitment to sustainable consumption has been confirmed at the 1992 Earth Summit in Rio, and in a number of programmes initiated by international organisations and governments at all levels. Nevertheless, government action on sustainable consumption focuses on the individual consumer (perhaps using misleading models of consumer behaviour) and on improving environmental efficiency of consumption rather than addressing scale issues or the social context and systemic dimensions. Over the last decade several strands of research on sustainable consumption (particularly sociological and anthropological research) have provided evidence which suggests that this dominant policy approach might be the reason for the relatively modest success of sustainable consumption initiatives.

As a contribution to the discussion we are testing the usage of systems thinking methods for the purpose of knowledge brokerage between science and policy aimed to help ‘manage the contradictions of sustainable consumption and economic growth’. The project *Linking Research and Policy Making for Managing the Contradictions of Sustainable Consumption and Economic Growth* (acronym RESPONDER) is one of the knowledge brokerage (KB) projects funded by the European Commission through the Seventh Framework Program for Research and Technological Development (FP7) to increase use of available evidence and scientific expertise in sustainable development and environmental policy making. RESPONDER attempts to bridge not only the science–policy gap but also the ‘pro-growth’–‘beyond growth’ discourse gap by recognising and linking four communities: ‘pro-growth’ scientists, ‘pro-growth’ policy makers, ‘beyond-growth’ scientists and ‘beyond-growth’ policy makers. This paper aims to present how the method of participatory systems mapping, developed in the project, can produce particular insights into problems related to sustainable consumption which lead towards a more complex and systemic understanding.

The next section introduces the discursive context of the RESPONDER project and presents our definition of sustainable consumption. The third section describes our systems thinking approach: the method of participatory systems mapping (PSM), developed for the purposes of the project, is explained and situated in the organisation of project's tasks and events. The fourth section provides an overview of four different ways of engaging with CLDs and demonstrates the different types of insight produced. The fifth section is devoted to conclusions.

## **2        The competing discourses of sustainable consumption**

Over the 1990s and 2000s a number of programmes on sustainable consumption has been initiated by international organisations such as UN or OECD as well as by a number of national governments and the European Union (Fuchs and Lorek, 2005; Berg, 2011; Fuchs, forthcoming). Most of these programmes share the same basic understandings and, contrary to the call of the Brundtland Report, are quite far from any serious challenge to the lifestyles of the affluent. First of all, sustainable consumption is not seen to be in contradiction with continued economic growth in the rich countries, and there is no mention of reserving consumption growth for poor people. As UNEP states in 2000: “sustainable consumption is not about consuming less, it is about consuming differently, consuming efficiently, and having an improved quality of life” (UNEP and CDG, 2000). The policy documents on sustainable consumption stay within the framework of the ecological modernisation discourse that emphasises win-win strategies: consumption can become more sustainable, new business opportunities emerge, and quality of life improve, all at the same time. This should be achieved by increasing the resource efficiency of consumption, encouraged mainly by market-based policy measures. Labelling of green products combined with information campaigns should help consumers to make informed choices and thus make it profitable for business to provide green products. Simultaneously, environmental taxation of resources, in particular energy and water, and of emissions of polluting substances could promote resource efficiency and reduce pollution. The actual toolbox included other instruments like direct regulation (bans on problematic substances, tightening of building regulations) and subsidies to consumers, e.g. for insulation, but direct regulation was not promoted as a part of the

win-win repertoire (Christensen et al., 2007). Politically, it was an attractive strategy to translate the alleged consumer sovereignty in free markets to consumer responsibility: if consumption does not become more sustainable, consumers can be blamed. The focus on improving the efficiency of consumption has been termed 'weak sustainable consumption' (used by Fuchs and Lorek, 2005, as a differentiation from 'strong sustainable consumption' which focuses on the pursuit of fundamental shifts in consumption patterns and reduced levels of consumption in the rich countries).

Considering the results of the first twenty years of consumer-oriented environmental policies, results have surely been achieved. Nevertheless, there are grounds for criticism. For instance, the combination of compulsory energy labelling, energy taxes and information campaigns has increased the efficiency of electrical appliances significantly, and various measures have reduced heat consumption per square meter. At the same time, however, critics point to an increase in the number of appliances and the area of heated space that counteract the achieved energy savings. In other cases, like transport and travelling, it has not been politically acceptable to follow the 'recipe': since mobility is considered decisive for economic growth and personal freedom, economic instruments have not been applied effectively, and energy consumption has increased considerably. Many areas of consumption are not addressed by environmental policies, and consumer-oriented environmental policies have not in any way questioned the continued rise in material living standards, the ongoing renewal of consumer goods, or the costly individualisation of consumption.

A new and related field of research developed over the last 20 years and interacted with policy making (for anthologies see e.g. Princen et al., 2002; Jackson, 2006; Reisch and Røpke, 2004). It has collected knowledge on environmental impacts of consumption, with the consumption clusters of food, mobility and housing identified as having particularly large impacts (Hertwich, 2006). A lot of research applied an individualistic perspective and concentrated on the understanding of consumer behaviour, trying to explain the attitude-behaviour gap and investigating the results of various interventions like taxes, eco-labels and information campaigns. Some research saw a solution in the identification of different consumer groups and lifestyles and addressing them in different ways. Nevertheless, under 'green consumption' it is perfectly possible for consumers to demonstrate their 'greenness' by carrying out a large number of token green practices and simultaneously increase their

environmental impacts considerably. Large segments of consumers have developed a sort of ‘compartmentalisation’ where only some categories of consumption are considered in environmental terms, while much ordinary consumption and increases of normal standards go unnoticed.

Concurrently with the individualistic-oriented consumer research, more sociological and anthropological perspectives were developed (Gronow and Warde, 2001; Southerton et al., 2004). Here the embeddedness of consumption activities within wider social, economic and technological frameworks was emphasised, and the interplay between systems of provision and consumption practices was explored. So far this strand of research has not been influential in policymaking, but this may be about to change. Maybe the limited results of the win-win strategies in terms of the overall environmental impacts of consumption have contributed to a search for broader approaches. The individualistic-oriented research increasingly tries to take ‘context’ into account (Thøgersen and Grønhøj, 2010), and sociologists try to develop more policy-oriented advice that goes beyond the traditional ABC (attitude–behaviour–choice) approach (Shove, 2010). Simultaneously, bottom-up experiments with more sustainable consumption and production patterns emerge and call for studies on the possibilities for scaling up (Seyfang, 2009).

Concepts which roughly correspond to the directions of these strands have been developed also in other sustainability literatures. It is possible to organise the literatures into a discourse focusing on the individual and ‘weak’ sustainability (with concepts of ecological modernisation, green consumption (Princen et al., 2002), responsible consumerism, or virtuous circle (Hobson, 2002: 132)), a discourse focusing on the individual and ‘strong’ sustainability (e.g. voluntary simplicity), and a discourse focusing on the social/systemic dimensions and ‘strong’ sustainability (de-commodification, or bioregionalism (Sale, 1985)). The RESPONDER project can be seen as tied to the last discourse. First of all, the challenge of sustainable consumption is considered in a global perspective where the focus on improved efficiency in consumption is replaced by ‘strong sustainable consumption’. Sustainable consumption is thus characterised along three objectives: a reduction of the overall consumption of resources to steer the socioeconomic system away from natural limits; the ethical challenge of redistribution of resource appropriation from rich to poor within and between nations; and the striving to achieve well-being, quality of life or a ‘good life’ (Buen Vivir) (see Scholl, 2011). Second,



consumers are not only considered in the role of buyers on a market, but also as practitioners that carry out meaningful practices and, at the same time, fulfil roles in broader socio-technical systems. Nevertheless, we do not push for a specific understanding, but rather expect that the mapping exercises expose a plurality of systemic aspects to facilitate policy-relevant learning.

### **3 Systems thinking and the method of participatory systems mapping (PSM)**

Systems thinking is a discipline developed from feedback concepts of cybernetics and servomechanism engineering theory (Senge, 1990). It provides a framework for holistic thinking while addressing complex societal issues. The core of systems thinking is seeing ‘wholes’ instead of ‘parts’, making sense of interrelationships between system components to understand what drives dynamic behaviour. Richmond (1993) advanced a set of critical thinking skills which cater for more holistic policy-making processes, including: i) dynamic thinking (the ability to deduce dynamic behaviour patterns rather than focusing on events), ii) closed-loop thinking (the ability to think in feedback terms leading to recognition of process interdependencies and endogenous causes of systemic change), and iii) operational thinking (the ability to understand the physical processes and ‘how things really work’). Research related to natural resource management, ecological economics and sustainable development was attracted to systems thinking since the end of 1960s, and particularly since the publication of *The Limits to Growth* (Meadows et al., 1972). In the area of sustainable consumption, the importance of systems thinking has been increasingly recognised over the recent years (see, e.g., Klingert, 1998; Geels et al., 2008; Timmer et al., 2009a, 2009b; Mont and Power, 2010; Soderquist, 2010; Prinnet, 2011). Nevertheless, as of now, a more thorough application of systems thinking is quite rare (see, e.g., Nemcskeri et al., 2008; Jackson, 2009; Green et al., 2010).

Approaches involving clients in systems thinking, applied since the 1970s, have over recent years evolved into, among others, group model building (Vennix, 1996) and mediated modelling (van den Belt, 2004). While providing structured platforms for participation and active engagement of inter-organisational stakeholder groups in policy and decision-making processes, these methods foster co-production of knowledge and group learning as outcomes of the modelling process (Videira et al.,

2009). They constitute settings which enable deliberation among participants and stimulate the development of critical thinking skills, such as the recognition of interconnections and feedback processes. In recent years, these methods have been increasingly used in the context of public policy making on natural resources (e.g. Hare et al., 2003; FLUF, 2010; van den Belt et al., 2010).

Causal loop diagrams (CLDs), shaped in particular by systems dynamics and cybernetics, are probably the most-utilised systems-thinking visualisation tool. Two widely recognised uses of CLDs are the transformation of verbal descriptions into feedback structure during early stages of model conceptualisation (Goodman, 1974), and the presentation of a ‘distilled’ understanding at the end of the whole modelling process (Morecroft, 1982). Since an underlying principle of systems thinking is that the behaviour of a system is the result of the structure of its elements, CLDs provide an endogenous explanation for observed behaviour. In RESPONDER we intend to test the use of CLDs for KB; we use CLDs as boundary objects (Cash et al., 2003) to (i) transform perceptions and mental models of individuals and groups into a causal and feedback structure, (ii) expand the boundary of thinking by enabling exploration and exchange of knowledge and paradigmatic and value positions accepted in various communities in the process, (iii) identify knowledge gaps through comparison with evidence-based and systematised knowledge, and (iv) formulate hypotheses about causes and effects and insights regarding system’s behaviour, and identify potential leverage points.

In the RESPONDER project we organise a number of thematic events in which the participants representing all four target communities engage with CLDs. At the time of this writing we were able to reflect on experience from workshops devoted to sustainable food consumption, sustainable mobility, sustainable housing and household saving and debt (sustainable finance); our findings will be demonstrated on an example from the mobility area. For the workshops we developed a method of ‘participatory systems mapping’ (PSM) building on participatory modelling approaches and applications (see Richardson and Andersen, 1995, Vennix et al., 1992; van den Belt, 2004; Videira et al., 2009). Since its inception we have tested the method on about 30 occasions in group sizes of 6 to 18 participants (excluding the facilitator). Application of PSM (see Figure 1) can best be described as the preparation and execution of a facilitated group process of development of causal loop diagrams to provide insights into a particular problematic issue and enable knowledge exchange.

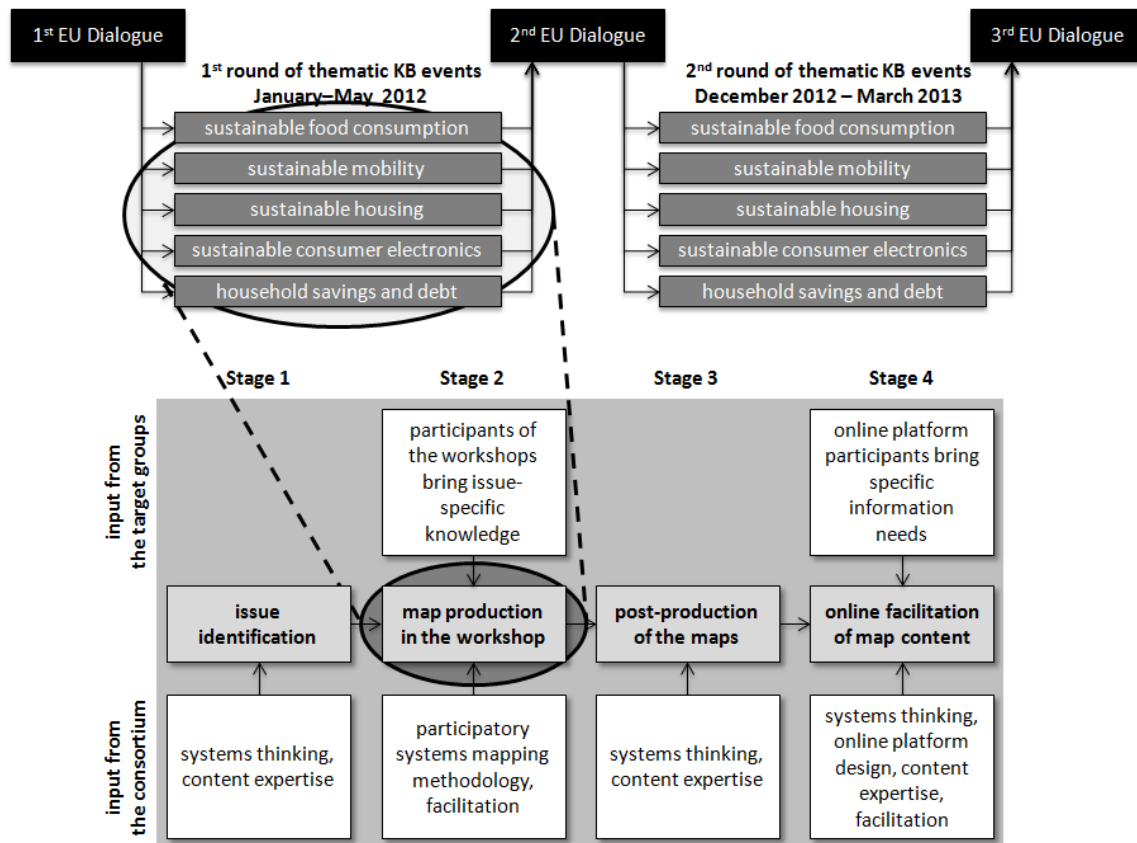


Figure 1. Structure of the RESPONDER events and of the CLD engagement process.

We have chosen to formulate a set of problem issues for each consumption area prior to the workshops. Each problem issue links sustainable consumption with macroeconomic (growth-related) concerns and is formulated as a guiding question which helps to manage the system boundary during the mapping process. The mapping itself was exploratory and (in the first round of events) diagnostic, i.e. aiming to describe the problems in their current situations and institutional contexts. The CLDs are constructed ‘physically’, meaning with sticky index cards placed on a large sheet of paper. Following the workshop the maps are digitalised and ‘cleaned up’ by removing inconsistencies and duplicities and correcting originally under-developed system structures. The processed CLDs will be placed in the RESPONDER online knowledge brokerage platform, enabling further interactive engagement.

Causal loop diagrams are expressed in a formal language originating in systems dynamics (Forrester, 1968) and cybernetics (Wiener, 1948; Ashby, 1956; Bateson, 1972). They depict causal relations between selected variables, focusing on positive and negative feedback loops and development trends. Causal relationships (positive or negative) are depicted as arrows, marked with a double slash sign whenever a time delay slows down the response.

We understand systems as purposive, transcending the subject/object boundary by connecting relevant elements of individuals, social systems and the natural environment through pathways and feedback loops (see also the ‘theory of the mind’ by Bateson, 1972). Systems thinking thus typically does not concern itself with the question of agency; agents are typically *hidden* in the assumptions or in the system goals and strategies. Furthermore, institutions (rules, norms etc.) are also rarely explicitly present; however, to a large extent they *enable* the depicted causal connections. Therefore structure can be understood as ‘objectively given’ by material and institutional conditions. Nevertheless, in relation to the context of participation and knowledge brokerage, we respect Churchman’s (1970) understanding of boundaries as ‘social or personal constructs that define the limits of the knowledge that is to be taken as pertinent in an analysis’, acknowledging that ‘[w]here exactly boundaries are constructed, and what the values are that guide the construction, will determine how issues are seen and what actions will be taken’ (Midgley, 2000: 35–36). The participatory design is supposed to address the valid concern of Dryzek (2005) of a technocratic elite of systems thinkers dictating societal solutions based on impenetrable computer models. PSM serves to provide an explicit picture of how participants see the system in positivist terms, and empower them to think of and deliberate on viable solutions. Furthermore, it should enable a discussion of boundaries (i.e. where lies the power to draw boundaries), as well as the assumptions and institutions behind the system’s structure. A specific type of boundary is the timeframe of the depicted system to which the stability of its structure is related; we understand the CLDs as ‘snapshots’ of systems at certain points in time. Systems continually evolve and change their structures, and sometimes they collapse and are reorganised radically (see, e.g., the adaptive cycle; Holling, 2001). More abstract system representations tend to be more useful for depicting longer time frames than detailed CLDs representing concrete situations.

#### **4        Achieving different types of insight with CLDs: a discussion**

The following sub-sections demonstrate some of the ‘lenses’ for thinking about CLDs and highlight what types of insight and learning effects they support.

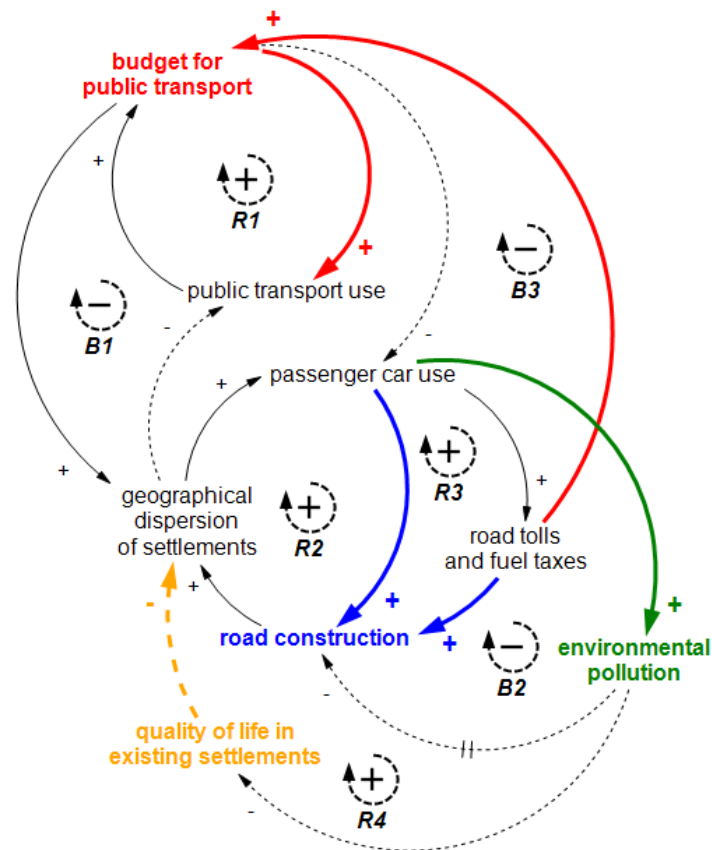


Figure 2. Public transport use vs. passenger car use map

Closed-loop thinking is a ‘lens’ which enables to think about interrelationships between feedback loops. Thereby it helps to understand and infer behaviour of systems over time. The map in Figure 2 shows a simplified excerpt from a system map from the mobility consumption area, mapping the issue “How does road construction influence transport volume and modal split?”. The excerpt highlights dynamic tensions between public transport use and passenger car use. For the sake of brevity a number of various variables is not included in the map (e.g. factors inhibiting switching from car use to public transport such as the symbolic value of private car and its use, population size, urbanisation structure, household incomes etc.) and many of the causal relationships are simplified (e.g. between budget and public transport use).

Even though inferring behaviour is not reliable without a simulation, CLDs still invite discussion on the relative strength of individual feedback loops and development trends. As an example, it could be theorised that the reinforcing loops related to passenger car use (R2, R3 and R4) are together much

more powerful than the balancing loop B2, and that therefore the resulting 'momentum' of the passenger car use cluster will be stronger than that of the cluster related to public transport (which has one moderately strong reinforcing loop and one moderately strong balancing loop). As a probable result, the geographical dispersion of settlements, which seems to be the most crucial variable in the map, would, unless meeting limits not depicted in the map, continually grow and cause a migration of public transport users to car users at an accelerating rate. The map also expresses several (surprising) statements:

- The only factors that counterbalance the growth of passenger car use are attractiveness and availability of public transport and the effect of pollution on road construction (through political mobilisation etc.). This opens a discussion on further possible balancing factors.
- Increasing availability of public transport would result in the settlements being more dispersed than they would otherwise have been and this would push public transport use down (with simultaneous growth of car use).
- The environmental pollution caused by car use contributes to further growth of car use: higher car use causes the quality of life in existing settlements be lower than it would otherwise have been, resulting in people moving out into 'quieter' or 'calmer' areas, and thereby contributing to further growth of the geographical dispersion of settlements which, unfortunately, additionally contributes to an increase in car use.
- Decreasing relative environmental impacts of car use actually worsens the problem: it weakens a counterforce to road construction, thereby leading to an increase of the scale of the problem.

Complementary to closed-loop thinking, it is possible to acquire a more detailed insight by examining variables critical for the system structure (such as the geographical dispersion of settlements in Figure 2) in more detail. A visualisation such as the one depicted in Figure 3 facilitates a discussion about interrelationships between influencing factors: Are the depicted causal factors sufficient to explain the behaviour of the variable? Are factors complementary (i.e. a multiplicative relationship) or substitutive (an additive relationship)? Are the functions between individual factors and well-being linear? What are the trade-offs between factors? Are some factors conditional or

inhibitive to other factors' effects? Is the effect of a factor dependent on an additional variable? Furthermore, what scientific evidence exists for particular causal relationships?

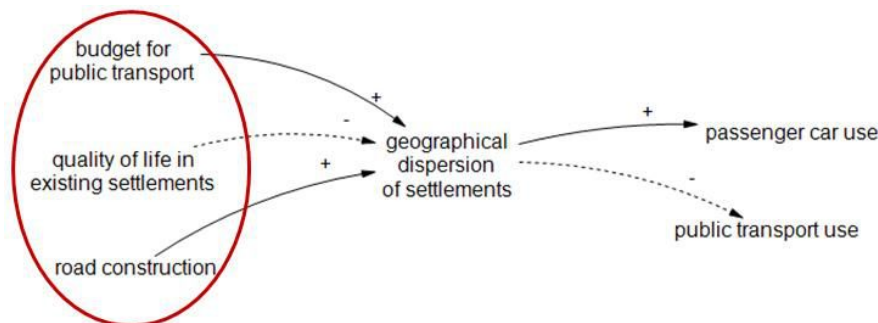


Figure 3. Geographical dispersion of settlements in focus

A third 'lens' consists of attempting to visualise different discourses, mental models or strategies to tackle the problem issue in a given CLD. This can be done by visualising: i) different goals in the system, associated with different paradigms; ii) visualising how an issue is defined and which causal links and feedback loops are perceived as dominant in different paradigms; iii) visualising different strategies (as we did with the use of the different colours in Figure 2). It is even quite possible that individuals and communities promoting the various strategies (and having unique discourses and mental models) would have a different perspective on the causal structure of the system, i.e. they might not perceive significant variables, relationships or leverage points, or not expect a number of side effects. Integration of different mental models or strategies, even though challenging, might bring a range of possible insights. In Figure 2, we represented the following strategies adopted to combat the negative effects of growing car use (congestion and increasing travel times in particular):

- Blue colour represents a 'more is better' strategy (or a conventional fixing-the-problem approach), when more roads are constructed, using the financial resources acquired from road tolls and fuel taxes.
- Red colour aims to strengthen the 'pull' of the public transport loop cluster. Budgets for public transport are increased, under the assumption that this will result in the public transport becoming more available and attractive, which increases public transport use (and ticket revenue) and decreases passenger car use. A particular effective option of addressing the

relative strengths of the public transport and passenger car loop clusters is to channel a share of collected road tolls and fuel taxes to public transport instead of road construction. The higher the share channelled, the stronger the leveraged effect (nevertheless, should public transport attract significantly more users, car use would drop and the income from road tolls and fuel taxes would decrease as well). Nevertheless, a stronger loop R1 would also more strongly contribute to the growth of geographical dispersion of settlements. A more robust solution would therefore also address the link between budgets for public transport and geographical dispersion of settlements, or between dispersion of settlements and passenger car use.

- Green colour represents the ‘ecological modernisation’ strategy of decreasing environmental impacts of car use (by a technological solution aimed at increasing fuel efficiency of cars or decreasing their noisiness). As stated above, this would make the link between car use and environment pollution weaker and as a result inhibit the balancing function of the loop B2 as well. Such a measure would also weaken the reinforcing loop R4 (i.e. less people would move into new settlements), but the economic and political reinforcing loops of R2 and R3 would have less counterforce.
- The orange colour represents the attempt to directly address the geographical dispersion of settlements by a ‘holistic’ strategy of increasing the overall quality of life in the existing settlements, thereby lowering the incentives leading their populations to move to new settlements.

The fourth ‘lens’ is examining connections between several problem issues. It has been suggested that ‘distilled’ depictions of the system structure underpinning particular issues can be linked in the manner of ‘cascaded archetypes’ (Wolstenholme, 2004: 350), illustrating how unintended consequences of one issue can become drivers in the next. Such a linking has remained a rarely-addressed ‘major research challenge for system dynamics’ (ibid.). Figure 4 shows how individual problems can act as mutual limits, balancing each other out and mutually preventing growth in scale. Structures of two heavily simplified problem issues are connected through conflicts over use of land. Pressure on land use and resulting conflicts result from increases in geographical dispersion of



settlements through road construction and take up of land through a shift towards regional food production. The stronger the policy goals, the more pressure would there be on conflicts over land use. Should, for example, the problem of low productivity of regional food production be solved, it would stop contributing to an increase in conflicts over use of land. As a result, there would be less counterforce to road construction and the scale of the problem of road construction and geographical dispersion of settlements could grow until it meets another 'layer of limits' (Meadows, 2008).

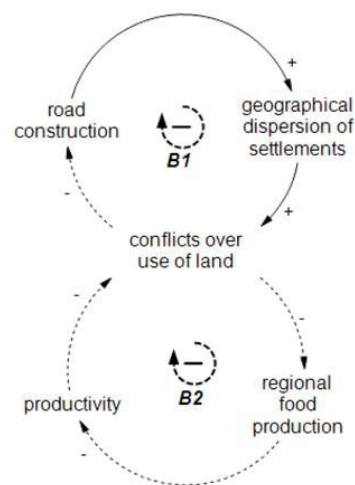


Figure 4. A possible connection between two problem issues

Another option is a cascade where change in one problem issue causes changes in the same direction in other issues. For example, policies aiming to decrease meat consumption could, provided they overcome policy resistance, over time contribute to the popularity of lifestyles of health and sustainability (LOHAS), which encompass more dimensions than just meat consumption. Increasing popularity of LOHAS could therefore plausibly result in an increase of preference for regional and seasonal diet or in an increase of public transport use to a level higher than it would otherwise have been, thereby potentially contributing to an improvement in the problem of car use. Analogously, a decrease in the popularity of LOHAS could affect these linked problems negatively. This example shows that addressing one problem may help solve other problems through systemic spillover effects, rather than the traditional behavioural spillover effect (Thøgersen and Ölander 2003).

## 5 Conclusions

In this paper we attempted to demonstrate how our usage of the method of participatory systems mapping (PSM) in the context of knowledge brokerage can support various types of insight, thereby supporting a systemic, complex and multi-perspectival understanding of issues related to sustainable consumption. Such an understanding can be reached by simultaneously using several ‘lenses’ to look at a single CLD. We described 4 different ‘lenses’ (an overview is provided in Table 1).

Table 1. An overview of different lenses and the insights they produce

‘Lens’	Produced insights
Closed-loop thinking	structural causes for observed behaviours, unintended consequences, limitations to policy measures, leverage points, explicit boundaries of thinking (detailed, issue-specific insight)
Factors of influence	implied relationships between factor of influence, necessary conditions for exertion of influence, identification of evidence gaps (detailed, issue-specific insight)
Mental models and strategies	different perspectives, comparison of mental models, comparison of strategies, placing paradigms into a larger picture (actor- and discourse-oriented insight)
Connections between issues	interlocking of problem issues, side effects of policy solutions, system boundaries, higher level of system organisation (policy resistance, resilience, path-dependencies) (‘inter-issue’ insight)

We have highlighted the discussion-supporting function of CLDs, which is particularly relevant for knowledge brokerage processes involving representatives of various communities. Furthermore, we tried to demonstrate that diagnostically used CLDs possess significant policy-relevant potential by enabling identification of leverage points which serve to conceptualise policy interventions and by supporting thinking about effectiveness, policy resistance and potential side effects of policy interventions. Structuring the problem issues using the language of CLDs also allows identification of missing evidence and knowledge needs of the policy makers (research-related potential). In line with Sterman (2000) we suggest that ‘improving’ the mental models upon which policy solutions are based

can to a large extent prevent unforeseen and delayed side effects which are the main threat to sustainability (see Figure 5).

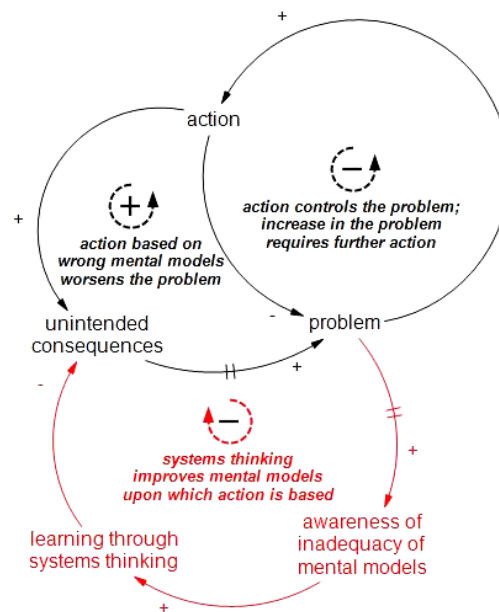


Figure 5. Systems thinking as a way to improve mental models

Our project is to be seen in the context of a stream of studies, initiatives and exercises which might collectively contribute to change of policy to more systemic understanding of sustainable consumption.

## References

- Ashby, W.R. (1956), *Introduction to Cybernetics*, Wiley & Sons: Chichester.
- Bateson, G. (1972), *Steps to an Ecology of the Mind*, Jason Aronson: Northvale, NJ.
- Berg, A. (2011), 'Not roadmaps but toolboxes: analysing pioneering national programmes for sustainable consumption and production', *Journal of Consumer Policy*, **34** (1): 9–23.
- Caplan, N. (1979), 'The two-communities theory and knowledge utilization', *American Behavioral Scientist*, **22** (3): 459–470.
- Cash, D.W., Clark, W.C., Alcock, F., Dickson, N.M., Eckley, N., Guston, D.H., Jaeger, J. & Mitchell, R.B. 2003. Knowledge Systems for sustainable development. *The Proceedings of the National Academy of Sciences*, **100** (14): 8086–8091.
- Christensen, T.H., Godsken, M., Gram-Hanssen, K., Quitzau, M. and Røpke, I. (2007), 'Greening the Danes? Experience with consumption and environment policies', *Journal of Consumer Policy*, **30** (2): 91–116.
- Churchman, C.W. (1970), 'Operations research as a profession', *Management Science*, **17**: B37–B53.
- Dryzek, J.S. (2005), *The Politics of the Earth: Environmental Discourses*. 2nd edition. Oxford: Oxford University Press.
- Estabrooks, C.A., Norton, P., Birdsell, J.M., Newton, M.S., Adewale, A.J. and Thornley, R. (2008), 'Knowledge translation and research careers: Mode I and Mode II activity among health researchers', *Research Policy*, **37** (6–7): 1066–1078.
- European Commission (EC) (2008), *Scientific Evidence for Policy-making*. EUR 22982 EN. Brussels: DG Research, Socio-Economic Sciences and Humanities.
- Foresight Land Use Futures (FLUF) (2010), *Systems Maps*, London: The Government Office for Science.
- Forrester, J.W. (1968), *Principles of Systems*, Cambridge, MA: MIT.
- Fuchs, D.A. (forthcoming), 'Sustainable consumption'. In R. Falkner (ed.), *Handbook on Global Environmental and Climate Policy*.
- Fuchs, D.A. and Lorek, S. (2005), 'Sustainable consumption governance: a history of promises and failures', *Journal of Consumer Policy*, **28** (3): 261–288.
- Geels, F.W., A. Monaghan, M. Eames and F. Steward (2008), *The Feasibility of Systems Thinking in Sustainable Consumption and Production Policy: A Report to the Department for Environment, Food and Rural Affairs*, London: DEFRA.
- Goodman, M.R. (1974), *Study Notes in System Dynamics*, Cambridge, MA: MIT.
- Green, K., M. Harvey and A. Mcmeekin (2010), 'Transformations in food consumption and production systems', *Journal of Environmental Policy and Planning*, **5** (2), 145–63.
- Gronow, J. and Warde, A. (eds.) (2001), *Ordinary Consumption*, Routledge: London and New York.
- Hare, M., R.A. Letcher and A.J. Jakeman (2003), 'Participatory modelling in natural resource management: a comparison of four case studies', *Integrated Assessment*, **4** (2), 62–72.
- Hertwich, E.G. (2006), 'Accounting for sustainable consumption: a review of studies of the environmental impacts of households'. In T. Jackson (ed.), *The Earthscan Reader in Sustainable Consumption*, Earthscan: London, pp. 88–108.
- Hobson K. (2002), 'Competing discourses of sustainable consumption: does the "rationalisation of lifestyles" make sense?', *Environmental Politics*, **11** (2), 95–120.
- Holling, C.S. (2001), 'Understanding the complexity of economic, ecological and social systems', *Ecosystems*, **4**, 390–405.
- Jackson, B. (2009), 'How should we encourage consumption at "sustainable levels": what are the underlying psychological and sociological drivers for consumption and the implications for policy in UK?', PhD thesis, Centre for Environmental Policy, Faculty of Natural Sciences, Imperial College London, supervisors B. Sheate and M. Tennant.
- Jackson, T. (ed.) (2006), *The Earthscan Reader in Sustainable Consumption*, Earthscan: London.
- Jackson, T. (2011), discussion held at the systems mapping workshop, RESPONDER project, Vienna, 3–4 May, unpublished.
- Klingert, S. (1998), 'A sustainable consumption scenario in a system dynamics model', available at URL: <http://web205.vbox-01.inode.at/ecopol/currentprojects/macrosd/suecons.pdf>.
- Meadows, D.H. (2008), *Thinking in Systems: A Primer*, White River Junction: Chelsea Green Publishing.
- Meadows, D.H., D.L. Meadows, J. Randers and W.W. Behrens III (1972), *The Limits to Growth*, New York: Universe Books.
- Midgley, G. (2000), *Systemic Intervention: Philosophy, Methodology, and Practice*, Kluwer Academic/Plenum Publishers: New York.
- Mitton, C., Adair, C.E., McKenzie, E., Patten, S.B. and Perry, B.W. (2007), 'Knowledge transfer and exchange: review and synthesis of the literature', *The Milkbank Quarterly*, **85** (4): 729–768.
- Mont, O. and K. Power (2010), 'The role of formal and informal forces in shaping consumption and implications for a sustainable society: part I', *Sustainability*, **2010** (2), 2232–52.
- Morecroft, J.D.W. (1982) 'A critical review of diagramming tools for conceptualising feedback system models', *Dynamica*, **8**, 20–29.
- Nemecskeri, R., Bodo, P., M. Herczeg and O. Mont (2008), *System Dynamics to Diagnose and Devise Patterns for Sustainable Consumption and Production: SYSCONS*, Lund.
- Oldham, G. and McLean, R. (1997), *Approaches to Knowledge-Brokering. International Institute for Sustainable Development*, Winnipeg: IISD. [http://www.iisd.org/pdf/2001/networks\\_knowledge\\_brokering.pdf](http://www.iisd.org/pdf/2001/networks_knowledge_brokering.pdf).
- Princen, T., Maniates, M.F. and Conca, K. (2002), 'Confronting Consumption'. In *Confronting Consumption*, 1st ed.; Princen, T., Maniates, M.F. and Conca, K., Eds.; The MIT Press: Cambridge, MA, USA; pp. 1–20.

- Prinet, E. (2011), 'Sustainable consumption & production', Background Paper #1, prepared as an independent third-party contribution to the North American Workshop on Sustainable Consumption and Production and Green Building, Ottawa, 31 January – 1 February.
- Reisch, L.A. and Røpke, I. (eds.) (2004), *The Ecological Economics of Consumption*, Edward Elgar: Cheltenham.
- Richardson, G. (1997), 'Problems in causal loop diagrams revisited', *System Dynamics Review*, **13** (3): 247–252.
- Richardson, G. and Anderson, D. (1995), 'Teamwork in group model-building', *System Dynamics Review*, **11** (2), 131–137.
- Richmond, B. (1993), 'Systems thinking: critical thinking skills for the 1990s and beyond', *System Dynamics Review*, **9** (2): 113–133.
- Sale, K. (1985), *Dwellers in the Land: The Bioregional Vision*, Random House: New York.
- Scholl, G. (2011), 'What is sustainable consumption?', RESPONDER background paper, available at: [http://www.scp-responder.eu/knowledge\\_base](http://www.scp-responder.eu/knowledge_base).
- Senge, P. (1990), *The Fifth Discipline: The Art and Practice of the Learning Organisation*, Random House Business Books: London.
- Seyfang, G. (2009), *The New Economics of Sustainable Consumption: Seeds of Change*, Palgrave Macmillan: Basingstoke and New York.
- Sheate, W.R. and Partidário, M.R. (2010), 'Strategic approaches and assessment techniques – potential for knowledge brokerage towards sustainability', *Environmental Impact Assessment Review*, **30**: 278–288.
- Shove, E. (2010), 'Beyond the ABC: climate change policy and theories of social change', *Environment and Planning A*, **42** (6): 1273–1285.
- Soderquist, C. (2010), 'Using systems thinking in a strategy as learning process: how systems thinking can support the 10YFP on SCP', 18th session of the UN Commission on Sustainable Development, 3–14 May 2010 UN's Sustainable Consumption Program, New York, 10 May.
- Southerton, D., Chappells, H. and Van Vliet, B. (eds.) (2004), *Sustainable Consumption: The Implications of Changing Infrastructures of Provision*, Edward Elgar: Cheltenham.
- Sterman, J.D. (2000), *Business Dynamics: Systems Thinking and Modeling for a Complex World*, Irwin McGraw Hill: Boston.
- Thøgersen, J. and Grønhøj, A. (2010), 'Electricity saving in households – a social cognitive approach', *Energy Policy*, **38** (12): 7732–7743.
- Thøgersen, J. and Ölander, F. (2003) Spillover of environment-friendly consumer behaviour. *Journal of Environmental Psychology*, **23**: 225 – 236.
- Timmer, V., E. Prinet and D. Timmer (2009a), 'Advancing sustainable household consumption: insights for effective policy development', presentation at the Sustainable Consumption Research and Action Initiative workshop, Worcester, MA, 15–17 October.
- Timmer, V., E. Prinet and D. Timmer (2009b), 'Sustainable Household Consumption: Key Considerations and Elements for a Canadian Strategy', prepared for Office of Consumer Affairs, Industry Canada, Ottawa: Consumers Council of Canada.
- UNEP and CDG (2000), *Sustainable Consumption and Production. Creating Opportunities in a Changing World*, Carl Duisberg Gesellschaft: Berlin.
- van den Belt, M. (2004), *Mediated Modeling: A System Dynamics Approach to Environmental Consensus Building*, Island Press: Washington DC.
- van den Belt, M., Kenyan, J., Krueger, E., Maynard, A., Roy, M. and Raphael, I. (2010), 'Public sector administration of ecological economics systems using mediated modelling', *Ecological Economics Reviews, Annals of the New York Academy of Sciences*, **1185**: 196–210.
- Vennix, J. (1996), *Group Model-Building: Facilitating Team Learning Using System Dynamics*, John Wiley & Sons: Chichester.
- Vennix, J., Andersen, D., Richardson, G. and Rohrbaugh, J. (1992), 'Model-building for group decision support: issues and alternatives in knowledge elicitation', *European Journal of Operational Research*, **59**: 28–41.
- Videira, N., P. Antunes and R. Santos (2009), 'Scoping river basin management issues with participatory modelling: the Baixo Guadiana experience', *Ecological Economics*, **68** (4), 965–78.
- Ward, V., House, A. and Hamer, S. (2009), 'Knowledge brokering: the missing link in the evidence to action chain?', *Evidence & Policy*, **5** (3): 267 – 279.
- WCED (1987), *Our Common Future*, Oxford University Press: Oxford.
- Wiener, N. (1948), *Cybernetics*, MIT Press: Cambridge, MA.
- Wolstenholme, E. (2004), 'Using generic system archetypes to support thinking and modelling', *System Dynamics Review*, **20** (4), 341–56.

## Environmental Attitudes among Management Practitioners in Trinidad and Tobago

Theme 4e – Responsible Investments and Corporate Behaviour

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### Abstract

*A major challenge in achieving sustainable development is the increasing environmental problems caused by industries. Integral in this scenario are management practitioners who are critical in shaping their organizations' policies relating to the environment. This paper examines the environmental attitudes of managers in Trinidad and Tobago, one of the most industrialized countries in the Commonwealth Caribbean region, using the New Ecological Paradigm (NEP) Scale. The findings reveal that the majority of managers are not pro-environmental, consequently severely hindering the implementation of sustainable development and the promotion of sustainable enterprises. The paper contributes to the ongoing sustainable development dialogue, particularly in the context of developing economies.*

**Key words:** sustainable development; sustainable enterprises; managers; environmental attitude; Trinidad and Tobago; environmental problems

### Introduction

Extensive studies on humanity's ecological footprint and assessments on ecosystems have all clearly revealed that humanity is already consuming more resources than the biosphere can replenish (Sutcliffe et al., 2008; Wackernagel et al., 2002; Heywood and Watson, 1995). The scale and speed in which natural resources (land, water, material, energy etc.) are being consumed is an urgent cause for concern because it has significant implications on our capability to develop in a sustainable manner. This level of consumption has led to climate changes, ozone depletion, deforestation, degradation of ecosystems and biodiversity loss. These increasing

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environmental problems which are linked to the evolution of society as well as that of the economy have led to the demand by different stakeholders for organizations to become more responsible and so align their business activities with environmental preservation and a proper management of natural resources (Buysse and Verbeke, 2003). Such demand has increasingly intensified overtime since ecological catastrophes caused by industries continue to be frequent (Sharma and Henriques, 2005). Consequently, the implementation of sustainable development progressively shifted from a government focus towards business and so the role of the firm in the sustainability discourse became critical. Firms are now expected to maintain and grow their economic, social and environmental capital base (Dyllick & Hockerts, 2002) to create sustainable societies.

Because business is important for achieving sustainability, the environmental attitudes among management practitioners and how they impact on the firm's environmental policies or decisions are therefore crucial for consideration. This paper uses the New Ecological Paradigm (NEP) Scale to examine environmental attitudes among management practitioners in Trinidad and Tobago (T&T). The article is intended as a contribution to the ongoing sustainable development debate particularly for developing economies such as T&T. The article is structured as follows: Section1 briefly discusses the concepts of sustainability and sustainable enterprises; Section2 outlines the existing environmental conditions in Trinidad and Tobago; Section3 provides details on the NEP; Section4 discusses findings and Section5 considers key implications and conclusions.

## **1. Sustainability and Sustainable Enterprises**

Striving to balance the rate of development with environmental protection is a fundamental aspect of the sustainable development concept. The key aim of the concept is "...meeting the basic needs of all and extending to all the opportunity to satisfy their aspirations for a better life" (WCED, 1987, p.45), using natural resources in particular. Sustainability is also essentially a forward looking concept whereby what is done in the present generation should not create a legacy that damages future generations (Morse et al, 2011). The concept is in no way limited to environmental and economic concerns but also includes a social dimension as well and requires that all three dimensions be integrated for long-term sustainability. This article however, as mentioned earlier, focused on the environmental dimension at the level of the firm.

Firms, irrespective of size, are the principal source of economic growth and employment creation and are at the center of economic activity and development in nearly all societies. They are vital stimulants that bring about change and progress by ensuring that economies remain dynamic, innovative and competitive (Baumol, 2002). Given their central role in wealth creation and development, enterprises need to ensure that their core business activities continue to add value and are undertaken efficiently and effectively (Buckley et al, 2009). So unlike the traditional perspectives which view enterprises in terms of linear input-output relationships focused solely on maximizing short-term economic value, a sustainable enterprise takes a more holistic and

long-term view integrating social, environmental and economic issues in doing business (Buckley et al, 2009).

The promotion of sustainable enterprises is increasingly becoming entrenched as a global approach to effectively implementing sustainable development. The Global Competitiveness Index (GCI) of the World Economic Forum, for instance, will begin measuring sustainable competitiveness in 2013 and has embraced the importance of assessing competitiveness through a sustainability framework. The GCI will be assessing the three dimensions of sustainability, but for the environmental dimension, the efficient use of resources, the management of renewable resources, and the degradation of the environment are the three aspects considered under the physical environment pillar of this subindex (CGI, 2011-2012, p.56). Although the implementation of sustainable development has largely shifted towards business, government is still essential for facilitating its implementation through policies and laws, for example.

## **2. Environmental conditions in Trinidad and Tobago**

Industrialized countries are generally considered to be major culprits for the environmental problems being experienced; however, developing countries or emerging economies are also liable. This is the case of Trinidad and Tobago<sup>3</sup> (T&T), one of the most industrialized countries in the Commonwealth Caribbean region. Environmental problems associated with the production of a range of commodities including but not limited to processed food, petroleum products, nitrogen, ammonia, urea, fertilizer, paint and wood products are prevalent. Likewise the demand for goods and services as a result of population growth and development has had negative impacts on the physical characteristics and natural resource base of the country.<sup>4</sup> Resource exploitation has been characterized by short-term economic gain with little attention to long-term sustainability (National Environmental Policy, 2005). Land-based activities have contributed to the impairment and loss of inland and coastal resources and ecosystems –wildlife, fisheries, mangroves and other wetlands, beaches and coral reefs. For example, discharges from industrial activities in the East/West Corridor of the island are deposited into the Caroni River and its tributaries.<sup>5</sup> Similarly, the Gulf of Paria has experienced damages as a result of intensive offshore petroleum exploitation and exploration operations on the west coast of the island. Further, rich wetlands are being rapidly converted for a variety of uses associated with human social development including residential, industrial, port and waste disposal (National Environmental Policy, 2005).

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<sup>3</sup> The Republic of Trinidad and Tobago is comprised of two islands. Trinidad is geographically larger and is more industrialized with a dominant oil and gas sector. Tobago in contrast is geographically much smaller with a dominant tourism sector.

<sup>4</sup> The national population is approximately 1.3 million and has been growing at an annual rate of approximately 0.5%, generating a corresponding growing demand for goods and services in an island state of relatively small size (1,980 sq. miles or 5,128 km<sup>2</sup>).

<sup>5</sup> The Caroni River is the largest in T&T.



The current environmental conditions in T&T have not occurred in the absence of environmental policies, regulations, treaties, conventions and authorities. Trinidad and Tobago has a National Environmental Policy, an Environmental Management Agency and has committed to over twenty international treaties and conventions on conservation and protection of the environment. The challenge however is the ineffective implementation, monitoring and enforcement of these various pro-environmental initiatives. Insights into T&T's practice of sustainability can also be gauged by the findings of the *Travel and Tourism Competitiveness Report 2011*. The Environmental Performance Index of this report ranked T&T 103 out of 163 economies or countries. Specifically, the findings indicated that environmental regulation is not stringent and the enforcement of these regulations is ineffective. In relation to carbon dioxide emissions, T&T has been identified as one of the largest emitters ranking 133 out of the 163 economies.<sup>6</sup> These studies suggest that there are significant challenges related to the practice of sustainable development in T&T and the findings of this article will provide additional explanations to this situation.

### **3. The New Ecological Paradigm (NEP)**

The sustainable development debate could be characterized by two key contrasting worldviews; anti-environmental and pro-environmental. The anti-environmental view has inherent anthropocentric beliefs and values that consider humans as superior and above nature. This worldview is manifested in the Dominant Social Paradigm (DSP) perspective which holds a belief in limitless resources, continuous progress and the necessity for growth (Albrecht et al, 1982). In contrast, the pro-environmental worldview, expressed firstly through the New Environmental Paradigm and later the New Ecological Paradigm (NEP), is based on beliefs about humanity's ability to upset the balance of nature, the existence of limits to growth for human societies, and humanity's right to rule over the rest of nature (Dunlap et al, 2000).

The New Environmental Paradigm used a 12 likert scale to measure three facets of its values but was later revised and renamed the New Ecological Paradigm (NEP) which encompasses a broader ecological view than the narrower environmental view addressed by the original scale. The New Ecological Paradigm (NEP) incorporates the original three facets of the paradigm (balance of nature, limits to growth, and anti-anthropocentrism), as well as two additional facets, anti-exemptionalism and eco-crisis (Aldrich et al, 2005). The NEP is therefore intended to measure whether an individual holds pro-environmental or anti-environmental beliefs and

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<sup>6</sup> Interestingly, tourism has been identified by the government as one of the key sectors to be developed as the country seeks to diversify its economy away from the dependence on oil and gas.

attitudes (Dunlap et al, 2000).<sup>7</sup> It was designed to identify five (5) possible components of an ecological worldview:

1. Limits of growth
2. Anti-anthropocentrism
3. The fragility of nature's balance
4. Rejection of exemptionalism (the idea that humans are exempt from nature's constraints) and,
5. The possibility of an ecocrisis (Dunlap et al, 2000).

The NEP consists of 15 likert scale questions, three on each component. Answers to each question are summed to calculate an NEP score. Individuals with a higher score are considered more environmental. Possible scores range from a minimum of 15 to a maximum of 75.

The NEP has become the most widely used measure of environmental concern in the world and has been accepted as a reliable and valid instrument for assessing environmental attitudes (Aldrich et al, 2005; Dunlap et al, 2000). It has been employed in hundreds of studies in dozens of nations. The NEP scale provides comprehensive coverage of key facets of an ecological worldview and has internal consistency (Dunlap et al, 2000) which makes it an appropriate instrument for our study.

#### **4. Findings**

The NEP was used to measure whether an individual holds a pro-environmental or an anti-environmental attitude. Three hundred and twenty-nine out of a total of 352 survey instruments comprised the final sample of this study. Twenty-three surveys were disqualified due to incompleteness and or nationality. Of the 329 valid questionnaires 226 (68%) were completed by managers located in Trinidad while 103 (32%) were completed by managers in Tobago. All respondents represented private sector organizations. There were 55% females and 45% males. In terms of age distribution, 41% were between 20 – 34 years, 37% were between 35 and 49 and 22% over 50 years old. In terms of education levels, 52% had attained at least a first degree while 43% had completed at least secondary level. Five percent had only a primary level education.

Table 1 below gives the New Ecological Paradigm statements with the associated response. The frequencies and descriptive statistics for the entire population are also provided. The statements are coded as such that higher values indicate stronger pro-environmental attitudes. Thus odd-numbered NEP statements are coded as follows:

- Strongly Agree = 5
- Somewhat Agree = 4
- Undecided = 3
- Somewhat Disagree = 2

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<sup>7</sup> The New Ecological Paradigm is a revised version of the New Environmental Paradigm, published by Dunlap et al, 2000.

- Strongly Disagree = 1

Values assigned to even-numbered statements are coded the exact opposite. Consistent with the boundaries used by Aldrich et al (2005), we assumed that an average NEP score less than 2.8 indicates an *anti-environmental attitude*, an average score between 2.8 and 3.2 indicates *indecisiveness*, and an average score greater than 3.2 indicates a *pro-environmental attitude* (See Table1).

**Table 1 – Descriptive Statistics**

No.	Questions	SD (%)	D (%)	UD (%)	A (%)	SA (%)	MEAN	SD
1	We are approaching the limit of the number of people the earth can support	10	31	21	24	14	3.02	1.23
2	Humans have the right to modify the natural environment to suit their needs	20	37	10	29	4	3.42	1.21
3	When humans interfere with nature it often produces disastrous consequences	4	9	7	49	32	3.97	1.03
4	Human ingenuity would ensure that we do not make the earth unlivable	6	30	30	33	6	2.95	1.05
5	Humans are severely abusing the environment	6	5	4	45	41	4.11	1.06
6	The earth have plenty of natural resources if we just learn to develop them	5	7	4	48	37	1.94	1.04
7	Plants and animals have as much right as humans to exist	1	6	5	41	46	4.24	0.90
8	The balance of nature is strong enough to cope with the impacts of modern industrial nations	17	55	15	9	5	3.72	0.99
9	Despite our special abilities, humans are still subject to the laws of nature	2	2	3	51	41	4.27	0.81
10	The so-called 'ecological crisis' facing human kind has been greatly exaggerated	16	54	15	13	3	3.66	0.99
11	The earth is like a spaceship with very limited room and resources	10	33	13	33	11	3.02	1.23
12	Humans were meant to rule over the rest of nature	8	31	14	34	13	2.85	1.21
13	The balance of nature is very delicate and easily upset	2	13	13	51	23	3.81	0.98
14	Humans would eventually learn enough about nature to learn how to control it	15	43	20	21	2	3.47	1.04
15	If things continue on their present course, we will soon experience a major ecological catastrophe	6	7	11	48	28	3.84	1.10

In addition, we have used the classification outlined by Kotchen and Reiling (2000) and segmented individuals into 3 groups based upon the sum of their NEP scores.<sup>8</sup> The groups are comprised as follows:

1. Respondents with an NEP score of 50 or less (those who have anti-environmental attitude)
2. Respondents with an NEP score of greater than 50 and less than 59 (moderately environmental) and,

<sup>8</sup> As outlined earlier, the NEP was designed to identify five possible components of an ecological worldview. The NEP 15 item scale questions are divided in groups of three for each of these five components. Answers to each question are summed to calculate an NEP score. Individuals with a higher score are considered more environmental. Possible scores range from a minimum of 15 to a maximum of 75.

3. Respondents with a score of 59 or more (pro-environmental attitude).

Using these scores and classifications, Table 2 provides greater insights into the attitudes of the respondents. ANOVA test shows that there are differences in the means scores for each group ( $p < .000$ ).

**Table 2 – NEP Sub-categories and Environmental Classification**

		Anti	Moderate	Pro
		n = 130	n = 167	n = 37
	<b>The reality of limit to growth (1, 6, 11)</b>			
1	We are approaching the limit of the number of people the earth can support	2.48	3.22	4.03
6	The earth have plenty of natural resources if we just learn to develop them	1.83	1.85	2.73
11	The earth is like a spaceship with very limited room and resources	2.53	3.18	4.05
	Overall Mean	2.28	2.75	3.60
	<b>Antianthropocentrism (2,7,12)</b>			
2	humans have the right to modify the natural environment to suit their needs	2.89	3.69	4.14
7	Plants and animals have as much right as humans to exist	3.94	4.38	4.70
12	Humans were meant to rule over the rest of nature	2.42	3.01	3.68
	Overall Mean	3.08	3.69	4.17
	<b>The fragility of nature's balance (3, 8, 13)</b>			
3	When humans interfere with nature it often produces disastrous consequences	3.53	4.19	4.59
8	The balance of nature is strong enough to cope with the impacts of modern industrial nations	3.24	3.94	4.41
13	The balance of nature is very delicate and easily upset	3.45	3.91	4.65
	Overall Mean	3.41	4.01	4.55
	<b>Rejection of exemptionalism (4, 9, 14)</b>			
4	Human ingenuity would ensure that we do not make the earth unlivable	2.69	3.02	3.49
9	Despite our special abilities, humans are still subject to the laws of nature	4.06	4.36	4.62
14	Humans would eventually learn enough about nature to learn how to control it	3.17	3.56	4.14
	Overall Mean	3.31	3.65	4.08
	<b>Eco-crisis</b>			
5	Humans are severely abusing the environment	3.72	4.25	4.86
10	The so-called 'ecological crisis' facing human kind has been greatly exaggerated	3.23	3.81	4.51
15	If things continue on their present course, we will soon experience a major ecological catastrophe	3.42	4.03	4.54
	Overall Mean	3.46	4.03	4.64

As can be seen from Table2, 40% of the respondents hold an anti-environmental worldview, 51% is seen as being moderately environmental and 10% hold a strong pro-environmental worldview. Consistent with the results of Table1, even the persons who expressed a pro-environmental view seem to think that there are an abundance of natural resources available to be developed. At the same time, all respondents including the anti-environmental agreed that the balance of nature is delicate and easily upset and if we continue with business as usual then we would be heading for an eco-crisis. Further all respondents shared the DSP perspective in the hope of the market economy and human ingenuity. This is an interesting scenario because all respondents support the assertion that business as usual would lead to disaster but simultaneously find it necessary to continue resource exploitation in order to pursue commercial interests for growth. However considering their response to item #4, both the moderately and pro-environmental groups are not confident that human ingenuity is capable of solving environmental problems.

The large number of respondents that are moderately environmental is also a point of concern. Given their overall mean for “the reality of limits to growth” it would seem to suggest that they are heavily swayed by their desires for commercial success in their respective spheres. The indecisive scores (between 2.8 – 3.2) on a number of items would also suggest that depending on the impact and direction of moderating factors/variables such as government policies and regulations, public information, company policies and strategic intent, managers can sway either to the anti or pro environmental positions.

There are some other notable attitudes that we need to highlight. In components 1 (reality of limit to growth), 2 (antanthropocentrism) and 4 (rejection of exemptionalism), both the anti-environmental and moderately environmental groups share DSP perspectives. Both believe that we have not reached our limit to growth and there is not a finite limit to the availability to natural resources. They also hold the view that man has the right to modify the natural environment since human ingenuity would ensure that we do not make the earth unlivable. Nevertheless, they both demonstrate some inconsistency or indecisiveness by also holding the view that the balance of nature is delicate and if things continue on their present course, we will soon experience an eco-crisis.

## **5. Implications/Conclusions**

The current findings have some important practical implications. First, this study shows the prevalence of an anti-environmental attitude among management practitioners which is consistent with and also partly explains the results of the Environmental Performance Index of the Travel and Tourism Competitiveness 2011 Report where T&T ranked 103 out of 163 countries. With such an environmental outlook it is reasonable to state that a DSP view is still entrenched in the psyche of T&T management practitioners. This means promoting sustainable enterprises will be very challenging and the implementation of sustainable development will therefore continue to be ineffective. In addition, the problem is compounded by the current lack of stringent environmental regulation and their ineffective enforcement suggesting that resource exploitation will continue to be characterized by short-term economic gain with little attention to long-term sustainability. Against this background it can be argued that companies will not voluntarily integrate environmental issues into their decision making nor aligned them into their

core business strategy. This means that businesses are generally reactionary in relation to the question of the environment. In short, sustainable development is not a strategic focus.

Second, the majority of managers are moderately environmental in their thinking and so do not grasp the gravity of the increasing global environmental problems. Consequently, with the pressure to pursue increasing profits in uncertain and highly competitive markets, concerns for the environment or sustainability can easily be sidelined. If these managers adequately understood the global environmental problems and their severe implications on humanity's capability to develop in a sustainable manner their environmental attitude might be different. Moderately environmental also implies an unclear and inconsistent position which in turn creates greater opportunities for irresponsible and unsustainable decisions relating to the environment.

Third, while the focus to implement sustainable development has shifted strongly towards business (Dyllick & Hockets, 2002), the current results demonstrate that the private sector of Trinidad and Tobago is unable to do so. If sustainable development is to be even moderately achieved, the government needs to play a leading and champion role. Fundamental changes are required in terms of introducing more stringent and relevant laws, regulation and policies. Enforcement mechanisms ought to also be significantly improved in order to get industry to comply and eventually become a major actor in implementation.

The goal of this paper is to contribute to the ongoing discussion on sustainable development particularly in the context of developing economies. Our key findings were derived from the use of the NEP Scale which indicated that a significant percentage of managers hold an anti-environmental attitude while the majority are moderately environmental. These findings have serious implications for T&T's ability to effectively implement sustainable development. Also this research can be further expanded to other countries of the Caribbean region since they are faced with similar concerns and effects as it relates to environmental sustainability. The scope of this study was limited to management practitioners; however, further research could give consideration to the effects of industry and firm variables in influencing sustainable practices. Also from a regional context, it would be valuable to investigate the relationship and impact between governments' environmental policies and regulations with the attitudes and behaviours of private sector decision makers.

## References

- Albrecht, D., Bultena G., Hoiberg E., & Novak, P. (1982), The New Environmental Paradigm Scale. *Journal of Environmental Education*, Vol.13, pp.39-43
- Aldrich, G., Grimsrud, K., Thacher, J., & Kitchen, M. (2005), Relating Environmental Ethical Attitudes and Contingent Valuation Responses Using Cluster Analysis, Latent Class Analysis, and the NEP: A Comparison of Methods
- Baumol, W.J. (2002). *The Free market Innovation Machine: Analyzing the Growth Miracle of Capitalism*, Princeton and Oxford: Princeton University Press.
- Buckley, Graeme, Salazar-Xirinachs, J., & Henriques, M. (2009). *The Promotion of Sustainable Enterprises*, International Labour Office: Geneva.
- Buyse K, & Verbeke, A., (2003), Proactive Environmental Strategies: A Stakeholder Management Perspective, *Strategic Management Journal*, Vol. 24, pp.453-470
- Dunlap, R., Van Liere, K., Mertig, A., & Jones, R. (2000), Measuring Endorsement of the New Ecological Paradigm: A Revised NEP Scale, *Journal of Social Issues*, Vol. 56, No.3, pp.425-442
- Dyllick, T., & Hockerts, K., (2002), Beyond the Business Case for Corporate Sustainability, *Business Strategy and the Environment*, Vol.11, No.2, pp.130-141.
- Heywood, VH., & Watson, RT (eds.), (1995), *Global Biodiversity Assessment*, Cambridge University Press, United Nations Environment Programme (UNEP): Cambridge.
- Kotchen, M. & Reiling, S., (2000), Environmental Attitudes, Motivations and Contingent Valuation of Nonuse Values: A Case Study involving Endangered Species, *Ecological Economics*, Vol.32, No.2, pp. 93-107.
- National Environmental Policy of Trinidad and Tobago,( 2005)  
[http://www.biodiversity.gov.tt/home/images/stories/pdf/national\\_environmental\\_policy\\_1.pdf](http://www.biodiversity.gov.tt/home/images/stories/pdf/national_environmental_policy_1.pdf),  
accessed 3 December 2011
- Morse, H., Vogiatzakis, I., & Griffiths, G., (2011), Space and Sustainability: Potential for Landscape as a Spatial Unit for Assessing Sustainability, *Sustainable Development*, Vol. 19, pp. 30-48.
- Sharma S., & Henriques, I., (2005), Stakeholder Influences on Sustainability Practices in the Canadian Forest Products Industry, *Strategic Management Journal*, Vol.26, 159-180.

Suctcliffe, M., Hooper P., & Howell, R., (2008), Can Eco-Footprinting analysis be used successfully to encourage more sustainable behavior at the household level?, Sustainable Development, Vol. 16, pp. 1-16.

World Economic Forum, (2011), "Global Competitiveness Report 2011-2012", Geneva [http://www3.weforum.org/docs/WEF\\_GCR\\_Report\\_2011-12.pdf](http://www3.weforum.org/docs/WEF_GCR_Report_2011-12.pdf), Accessed 10 April 2012

World Economic Forum, (2011), "The Travel and Tourism Competitiveness Report: Beyond the Downturn 2011", Geneva

[http://www3.weforum.org/docs/WEF\\_TravelTourismCompetitiveness\\_Report\\_2011.pdf](http://www3.weforum.org/docs/WEF_TravelTourismCompetitiveness_Report_2011.pdf),  
Accessed 21 March 2012

Wackernagel, M., Schulz, NB., Deumling, D., Linares, AC, Jenkins, M., Kapos, V., Monfreda, C., Loh, J., Myers, N., Norgaard, RB., & Rander, J., (2002), Tracking the Ecological Overshoot of the Human Economy, Proceedings of the National Academy of Sciences of the United States of America, Vol.99, No. 14, pp.9266-9271.

World Commission on Environment and Development (WCED), (1987), Our Common Future, Oxford University Press: Oxford



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**Corporate social responsibility and food risk management in  
China, a management perspective**

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Abstract: this study aims find relationship between corporate social responsibility (CSR) and food risk management, and other influencing factors of food risk management in China. This is considered from the perspective of food company managers. 161 food companies were surveyed in Henan Province and Wuhan City, and our result indicates that the company's attitude (defensive/passive/proactive) to CSR affects its attitude to food safety management. And CSR performance of a company affects the effectiveness of its food safety management measures. With better CSR performance, a company experiences less risk than the ones with less good CSR performance. Other FRM affecting factors are also found.

## **1. INTRODUCTION**

With the economic growth and development of populated city centres, China's food industry has grown very fast. The average annual growth rate of its gross value of industrial output of food industry was over 13% From 1980 to 2001 (Bai et al, 2007), and it was 25.2% from 2005 to 2010 (Xiong, 2011). But along with this 'high speed' development comes more and more food safety related issues. Food safety initially emerged in China as a trade issue in the early years of the 21st century but has now become an important domestic food issue (Wang et al, 2008). Food safety concerns have become a major concern in domestic food markets since 2003 due to a string of food safety related incidents.

In 2008, just before the Olympic Games in Beijing, six babies were killed and 300,000 were left sickened after consuming infant formula contaminated with the industrial chemical melamine (BBC News, 2010). In April 2011, police in the north-eastern city of Shenyang seized 40 tons of tainted beans-prouts. The vegetable had been treated with sodium nitrite and urea, as well as antibiotics and a plant hormone called 6-benzyladenine. The chemicals were used to make them grow faster and look 'shinier' in the market stalls (AP, 2011). Clenbuterol, known as 'lean meat powder', can accelerate fat burning and muscle growth, making it an attractive feed additive, sports performance enhancer and slimming drug, but overdoses can cause illness and, in rare cases, death. In 2006, more than 300 people in Shanghai were sickened by pig

products, in 2009, 70 people were hospitalized in Guangzhou after eating tainted pig organs, and in 2010, 13 people in Shenzhen were hospitalized after eating clenbuterol-tainted snake (Olesen, 2011). Published research claimed that up to 10% of rice sold in China was contaminated with cadmium, a heavy metal known to cause cancer (Mahr, 2011). Other related incidents include fraudulent products, and sale of food beyond its expiration date. And microbial contamination is an on-going problem that results in many illnesses and deaths in China.

Recent opinion polls rank food safety among the top concerns of Chinese consumers, and food safety measures aimed at the domestic market were issued at a rapid clip. In response, the Chinese Government has begun to be concerned with food safety and is paying increasing attention to the country's food safety system (Zhang, 2005). In China, the role of the government is particularly influential and prominent given its political and industrial framework. The Chinese government facilitates, endorses and regulates the entire food system and food producers have a limited role in food safety regulation. One issue is that there are too many small enterprises, many of them illegal, to monitor in China's food manufacturing and processing industry. For example, approximately 350,000 of China's 450,000 registered businesses in food production and processing industry employ as few as 10 people or less, thus posing a major challenge to food safety management in the country (Dellios et al. 2009). As a result, the public tends to heavily rely on the government in developing comprehensive strategies to build an efficient food safety management system. In response to the public's understandable expectation toward government's role in food risk management (FRM), the Food Safety Law of the People's Republic of China, which was adopted at the 7<sup>th</sup> Session of the Standing Committee of the 11<sup>th</sup> National People's Congress of the People's Republic of China on 28 February 2009, was promulgated and came into force on 1 June, 2009. This law is enacted to ensure the food safety and guarantee the safety of the lives and health of the general public. It includes General Provisions, Monitoring and Assessment of the Food Safety Risks, Food Safety Standards, Food Production and Business Operation, Food Inspection, Import and Export of Food, Handling of Food Safety Accidents, Supervision and Administration, and Legal Liabilities.

A few studies have been implemented in the area of food safety in China trying to explore Chinese consumers' perception regarding food safety issues. Zhang (2005) did a case study in a big Chinese city, Tianjin, to try to gain insights into Chinese consumers' knowledge and concerns over food safety. The results indicate that Chinese consumers are unsurprisingly very much concerned about food safety, particularly with regard to vegetables and dairy products. However Chinese consumers know little about genetically modified (GM) and organic food. It was also found in the same study that young and highly educated consumers are willing to buy GM food in the future after being explained what GM food is. Wang et al (2008) surveyed consumers in Beijing regarding their awareness, willingness to pay, and price premium for milk products which have been subject to Hazard Analysis Critical Control Point (HACCP) management; a quality management system used to reduce food safety risks. It was found that less than 20% of respondents had not heard of HACCP, and after receiving information on HACCP then nearly all respondents were willing to pay a modest price premium for HACCP-certified products. Hence Wang concluded that the demand for food safety attributes is becoming higher amongst Chinese consumers.

Kim (2012) conducted a comparative survey study in China and Korea to understand how consumers evaluate the quality of the food risk management practices that are performed by the respective government and to determine the underlying psychological factors influencing consumer evaluation of food risk management quality (FRMQ). It was found that the perceived expertise of food managers was the most important influencing factor for Chinese consumers, while the proactive consumer protection was most important for Korean consumers. Scepticism in risk assessment and the communication practice was found to be the second most important factor in both Korea and China.

However, although government legislation can direct food companies to ensure their product is safe, it is still to a great extent up to the companies as to how far they want to go in producing safe food. This is where the concept of corporate social responsibility (CSR) comes into play. CSR recognizes that corporate growth and profitability are important, but it also requires a firm to pursue societal goals such as environmental protection, social justice and equity (Wilson, 2003; Moon, 2007; Lee,

2008; Bazin, 2009; Weyzig, 2009; Freeman et al, 2011). This concept of CSR stresses that each firm should not just stick to the direction they receive from legislation, as important as that is, but take initiatives to assume their social responsibilities. Given the very large number of companies involved the solution of the wide spread food safety crisis in China has to rest in part upon CSR. Only a socially responsible firm could be able to take full responsibility for the safety of their product. But this clearly raises all sorts of challenges, especially as not all companies will recognise that they have a CSR or, if they do, they may well interpret this in a variety of ways. Bai et al (2007) discussed detailed food safety assurance systems in China, including the current food safety situation and the functions of food safety regulation agencies. They have argued that stringent government legislation can pressurize the big food firms to produce safe food due to their high public visibility, but the food safety issue of millions of small food firms can only be solved by encouraging voluntary implementation of the legislation. But how best to do this? There have been many discussions focusing on the effectiveness of the current food risk management systems in China and how best to implement the government food safety legislation in Chinese food companies. Most of the work so far has been trying to address the above mentioned issues from the perspective of consumer demand, and few has looked at the problems from the angle of CSR.

The research summarised here aimed to explore the relationship between CSR and the effectiveness of food risk management of Chinese food companies. It was based upon the following questions:

- (1) Has a company's attitude to CSR influenced their way of risk management?
- (2) Is there a connection between the CSR performance of a company and the effectiveness of their risk management?
- (3) What other factors that can affect the effectiveness of a food company's risk management measures?

These questions are considered in the context of China and evidence is drawn from a group of 161 food companies in Henan Province and Wuhan City of Hubei Province in China.

## **2. METHODOLOGY**

### **2.1 Sampling frame**

A convenience sampling method was employed. 180 food companies that are based in the Henan Province and Wuhan City in China were selected because they have had a relationship with one of the author's institution. Each company was given a questionnaire to complete, and the targeted respondents were managers who were responsible for product safety. A total of 161(89%) completed and valid questionnaires were returned (see Table 1). Of these returns:

- 126 (78%) were located in Henan Province, and 35 (22%) were in Wuhan City.
- 23 (14%) of them were founded 20 years ago, 21 (13%) were founded after 2006, 68 (42%) were founded between 1990 and 1999, and the rest (30%) were founded between 2000 and 2005.
- most of the companies were private and sino-foreign joint venture companies (74%), 17 (11%) are state-owned company, 12% of them are public listed companies.
- 33 (20%) have 500 thousand Yuan YMB of registered capital, 40 (24%) have more than 10 million Yuan, while 27 (17%) registered with between 510 thousand and 1 million Yuan, and 39 (24%) registered with 1-5 million Yuan.
- 45 (28%) of the survey companies have 50 or less employees, 19 (12%) have more than 1000 employees, 16% have employee number of 501-1000, 32% have 101-500, and 13% have 51-100 employees.

The above information of company size, scale, ownership indicates that the surveyed companies were representative of the broader landscape of Chinese food companies.

## 2.2 Data collection

After a pilot study in December 2011, the questionnaire was finalized and comprised a mix of closed and open-ended questions aimed to uncover food companies' current risk management and CSR situation as well as the manager's attitude to food risk management and CSR. Only the General Manager or the food safety risk manager (if they had one) was interviewed; one respondent for each company. The fieldwork was undertaken in Henan Province and Wuhan City simultaneously from February to April 2012.

The Henan Province part of the survey was carried out by undergraduate students based in Henan Agricultural University, and the Wuhan part was carried out by one undergraduate student from Wuhan University. The questionnaires were administered via face-to-face interview, telephone interview and email. All students received survey skills training before the survey, including understanding of the survey questions, how to approach respondents etc. Of the 161 completed (and valid) questionnaires received, 120 questionnaire in Henan Province and 20 in Wuhan were answered face-to-face, 10 in Henan and 2 in Wuhan were finished by telephone interview and 28 questionnaire were sent to respondents via email.

## 2.3 Data analysis

A Likert scale system was employed to code qualitative data, and SPSS 19.0 was employed to store and analyse data. Correlation analysis, crosstab, regression were used to analyse the data.

# 3. RESULTS

## 3.1 The current FRM situation of the case companies

During the survey, the authors investigated the occurrence of food safety incidents (OFSI) of the case companies for the last 3 years (see Table 3). The most frequent food safety incident was 'product being copied by competitors', then it is 'recall',

‘employee being sluggish at work’, and ‘sharp reduction of profit’ etc. It indicates that the perceived risk of food industry is mainly product being copied by competitors and product recall. The surveyed companies considered that 7.88% of their yearly budget should be spent on FRM, while the actual spend was only 6.67% (see Table 4). This indicates that food companies spend less than expected on FRM. Table 5 shows the survey result of the early warning system of the case companies. A significant proportion (42.8%) of the surveyed companies claim that they do not have, have few or do not know if they have an early warning system. This suggests that these food companies currently do not see the importance of FRM. In addition, the companies would appear not to have learned much from the food safety incident that happened in the same industry in the past with average mark of 3.64 based on 1-5 scale (see Table 6). Of which who claimed to have learned from previous incidents, only 35% actually take measures to prevent future incidents.

Table 6 indicates that company CEOs are supportive of food risk management (with average rank of 4.34), but the senior managers did not receive enough training in risk communication and risk management with average ranks of 3.51 and 3.46. Table 7 indicates that all surveyed companies take actions when crises arise, but 6.8% of them are passive/reactive while 93.2% claim to be proactive.

The above analysis indicates that FRM is not given enough attention in the surveyed food companies, and it seems reasonable to assume that this may well apply to all food companies in China. Although the CEOs support the FRM in their companies and 93% of the surveyed companies claim that they are proactive in dealing with food risk, in reality they actually spent little money on FRM and almost half of them did not have an early warning system in place. Unfortunately this suggests that they have not learnt from previous mistakes in the food industry. So the results of this research suggest that the whole food risk management situation in China is very serious, and with the on-going food safety incidents in recent years, it is urgent for China to strengthen its food risk management system and improve food safety level. It is important not only for Chinese people but also for the rest of the world with China being the major exporter of agricultural products (Waves, 2006). It is clearly not only a matter of creating new legislation but making sure that legislation is communicated and achievement is monitored.



### 3.2 Corporate social responsibility and food risk management

#### 3.2.1 The company's attitude to CSR affects its attitude to FRM

As discussed above, producing a safe product should be a part of a company's CSR. Hence it may be assumed that a company's attitude to CSR might affect its attitude to food risk management – defensive/passive/proactive CSR attitude might be related to the same type of FRM attitude.

Table 8 indicates that the companies' attitude to CSR and FRM are strongly correlated ( $P < 0.001$ ). With  $R^2$  of 0.102 and  $P$  value of both coefficients are  $<0.001$  (see Table 9a, b), the regression analysis result indicates that the company's attitude to CSR affects its attitude to FRM.

#### 3.2.2 CSR performance of a company affects the effectiveness of FRM

Since a company's attitude to CSR affects its attitude to risk management, it might be the case that a company's CSR performance influences the effectiveness of the risk management measures. In this study, CSR performance is marked on the 1-5 scale; the lower the score then the better the CSR performance. Here the occurrence of food safety incidents is employed as an indicator of effectiveness of FRM. Crosstab (Table 10) between these two indicators indicates that the occurrence of food safety incidents for companies with CSR performance mark of 1-3.5 (better CSR performance) is 31, and for companies with CSR performance mark of 4-5 (worse CSR performance) is 113. Clearly companies with good CSR performance experience less risk than the ones with less good CSR performance. So the CSR performance of a company does seem to affect the effectiveness of the risk management.

### 3.3 Other factors that affect the effectiveness of a food company's risk management.

The result of a correlation analysis between the occurrence of food safety incidents (OFSI) and other factors that might affect it are shown in Table 11. The possible 'affecting factors' include who is the decision maker of the company (F1), level of

support the CEO gives to FRM (F2), changing trend of the level of support that the CEO gives to FRM in the last 5 years (F3), budget for FRM (F4), status of the FRM early warning system (F5), the amount of trainings managers received regarding risk communication (F6), the amount of training managers received regarding risk management (F7), the importance of FRM for improving organizational behaviour (F8), the change of profit over the previous 3 years (F9). It was found that factors such as who is the decision maker of the company (F1), level of support the CEO given to FRM (F2), changing trend of the level of support that the CEO gives to FRM in the last 5 years (F3), the amount of training managers received regarding risk communication (F6), and the change of profit over the previous 3 years (F9) are not related to OFSI. Therefore there are 4 affecting factors, which include budget for FRM (F4), status of the FRM early warning system (F5), the amount of training managers received regarding risk management (F7) and the importance of FRM for improving organizational behaviour (F8).

To further understand the relationship between OFSI and its affecting factors, multiple regression analysis was carried out (Table 12a, b). The results indicate that with an  $R^2$  of 0.151, only the budget for FRM (F4) passed the significance test. Hence the direct influencing factor of OFSI is the budget for FRM (F4). The rest of the factors i.e. status of the FRM early warning system (F5), the amount of training managers received regarding risk management (F7), the importance of FRM for improving organizational behaviour (F8) may well influence the OFSI, but there is no evidence of a direct causality between them.

#### **4 DISCUSSIONS AND CONCLUSION**

The results of this research reported here indicate the relationship between CSR and a food company's risk management and other affecting factors of the effectiveness of food risk management. The case study companies are of different size, scale, ownership, and history, they are representative of Chinese food companies. Hence the research result is generable in China.

Despite the government's effort of ensuring safe food by introducing relevant laws and legislations, food companies in China has not realized the urgency of food risk management. It can be reflected from the fact that almost half of the surveyed companies in this study did not have an early safety warning system in place, they also would not spend much on FRM, senior managers did not receive enough training in risk communication and risk management, and the companies had not learned the lesson from the food safety incidents happened in the past. Therefore, in an effort to help with the current situation from a more difference perspective, corporate social responsibility is introduced in this research.

It was found that a food company's attitude (defensive/passive/proactive) to CSR affects its attitude to FRM. And CSR performance of a company affects the effectiveness of its FRM. With better CSR performance, a company experiences less risk than the ones with less good CSR performance. Other FRM affecting factors are also found, they include the company's budget for FRM, status of its early warning system, the amount of training managers received in risk management, and the level of importance of FRM for improving organizational behaviour. However, only the budge for FRM is the direct influencing factor of the effectiveness of FRM.

## **References:**

- AP, 2011. Tainted bean sprouts latest food scare in China, 20 April 2011. Retrieved on 27 May 2012, from <http://dawn.com/2011/04/20/tainted-bean-sprouts-latest-food-scare-in-china/>
- Bai L, Ma C., Gong S., and Yang Y., 2007. Food safety assurance systems in China. *Food Control* 18, 480-484.
- Bazin D., 2009. What exactly is corporate responsibility towards nature? Ecological responsibility or management of nature? A pluri-disciplinary standpoint. *Ecological Economics* 68(3), 634-642

BBC News, 2012. Tainted milk scandal resurfaces in China, 25 January 2010.

Retrieved on 27 May 2012, from <http://news.bbc.co.uk/2/hi/8478195.stm>

Dellios R., Yang X.H., Yilmaz N.K., 2009. Food safety and the role of the government: implications for CSR policies in China. *iBusiness* 1, 75–84.

Freeman I., and Hasnaoui A., 2011. The meaning of corporate social responsibility: The vision of four nations. *Journal of Business Ethics* 100, 419-443.

Kim R. B., 2012. Consumers' perceptions of food risk management quality: Chinese and Korean evaluations. *Agricultural Economics – Czech*, 58(1), 11-20.

Lee M-D P., 2008. A review of the theories of corporate social responsibility: Its evolutionary path and the road ahead. *International Journal of Management Reviews* 10(1), 53-73.

Mahr, K., 2012. 12 Million Tons of Chinese Rice Contaminated 23 February 2011.

Retrieved on 27 May 2012, from <http://newsfeed.time.com/2011/02/23/12-million-tons-of-chinese-rice-contaminated/>

Moon J., 2007. The contribution of corporate social responsibility to sustainable development. *Sustainable Development* 15(5), 296-306

Olesen A., 2012. Lean meat powder' banned in China , 27 January 2011. Retrieved on

27 May 2012, from <http://www.washingtontimes.com/news/2011/jan/27/lean-meat-powder-banned-in-china/?page=all>

Wang Z., Mao Y., and Gale F., 2008. Chinese consumer demand for food safety attributes in milk products. *Food Policy* 33, 27-36.

Weyzig F., 2009. Political and Economic Arguments for Corporate Social Responsibility: Analysis and a Proposition Regarding the CSR Agenda. *Journal of Business Ethics* 86(4), 417-428

Wilson M., 2003. Corporate sustainability: what is it and where does it come from? *Ivey Business Journal* 67(4), 1-5.

Xiong B., 2011. Summary of 2010's economic performance of food industry and the outlook for 2011 (in Chinese: 2010 nian shipin gongye jingji yunxing zongsh ji 2011 nian zhanwang). Chinese Food Safety Newspaper, 18 May 2011.

Zhang X., 2005. Chinese Consumers' concerns about food safety. *Journal of International Food & Agribusiness Marketing* 17(1), 57-69.

Table 1 Summary of attributes of surveyed companies

	Number of surveyed companies: 161				
Area	Henan Province		Wuhan City		
	126 (78%)		35 (22%)		
Found time	Before 1989 (inc.1989)	1990-1999	2000-2005	2006-2010	
	23 (14%)	68 (42%)	49 (30%)	21 (13%)	
Ownership	State-owned	Sino-foreign joint venture	Private	Public listed	Others
	17 (11%)	35 (22%)	83 (52%)	19 (12)	7 (4%)
Registered capital (10 thousand Yuan)	Less than 50 (inc.50)	51-100	101-500	501-1000	Above 1000
	33 (20%)	27 (17%)	39 (24%)	22 (14%)	40 (25%)
number of employees (person)	Less than 50 (inc.50)	51-100	101-500	501-1000	Above 1000
	45 (28%)	21 (13%)	51 (32%)	25 (16%)	19 (12%)

Table 2. Summary of food safety risk management (FRM) and CSR indicators in a food company

FRM related indicator	CSR related indicator
<p>Current situation of FRM:</p> <ol style="list-style-type: none"> <li>1. Level of support the CEO gives to FRM</li> <li>2. The changing trend of the level of support that the CEO gives to FRM in the last 5 years</li> <li>3. The budget for FRM</li> <li>4. Status of the FRM early warning system</li> <li>5. Lessons learned from the past food safety incidents in the same industry</li> <li>6. Measures taken after previous incidents</li> <li>7. Trainings managers received regarding risk communication</li> <li>8. Trainings managers received regarding risk management</li> </ol>	<p>Current situation of CSR:</p> <ol style="list-style-type: none"> <li>1. Take responsibility only if it is good for profit increase</li> <li>2. Take minimum responsibility required legally</li> <li>3. CSR is the company long-term strategy</li> </ol>
<p>Company's attitude to risks:</p> <ol style="list-style-type: none"> <li>1. Defensive - taking no measures when the crisis arise</li> <li>2. Passive/reactive – taking measures during the crisis as responses to the public/media pressure</li> <li>3. Proactive – having measures in place before crisis</li> </ol>	<p>Attitude to CSR:</p> <ol style="list-style-type: none"> <li>1. Defensive – no CSR apart from profit making</li> <li>2. Passive/reactive – take when it is legally required</li> <li>3. Proactive – take as part of company strategy</li> </ol>
Effectiveness of FRM: Occurrence of food safety incidents (OFSI)	

Table 3. Occurrence of food safety incident in the last 3 years

Type of incident	Number of occurrence in the last 3 years		Number of responding companies
	Maximum occurrence	Total occurrence	
1. Product being copied by competitors	8	117	153
2. Recall	6	95	153
3. Employees being sluggish at work	5	92	152
4. Sharp reduce on profit	5	89	152
5. Resignation of senior management	4	57	154
6. Natural disaster	5	39	152
7. Impairment of brand	5	37	151
8. Loss of sensitive information	5	34	152
9. Impairment of brand (negative comments from the media)	3	33	152
10. Major lawsuit	3	30	152
11. Fire, blast, chemical spill etc	5	24	152



Table 4 Spending on food risk management

	Maximum spend	Average spend	Number of companies surveyed
% of the yearly budget actually spent on FRM	15	6.67	126
% of the early budget that should be spent on FRM?	20	7.88	134

Table 5 Status of the early warning system of the case companies

Is there early warning system in your company?	Number of responses	Percentage (%)
Not at all	6	4
Few	22	14
Don't know	40	25
Yes, some	64	40
Yes, complete system	27	17
Total	159	100

Table6 Descriptive analysis of food risk management of the case companies (the ranks are based on 1-5 scale)

	Minimum rank	Maximum rank	Average rank	Standard deviation	Number of respondents
How much has been learned from past food safety incidents?	1	5	3.64	0.91	154
Level of support the CEO gives to FRM	1	5	4.34	0.69	161
The amount of training managers received regarding risk communication	1	5	3.51	0.92	158
The amount of training managers received regarding risk management	1	5	3.46	0.89	

Table7 Company's attitude to risks:

	% within total respondents	Number of respondents
Defensive - taking no measures when the crisis arise	0	0
Passive/reactive – taking measures during the crisis as responses to the public/media pressure	6.8	11
Proactive – having measures in place before crisis	93.2	150
Total	100.0	161

Table 8 Correlation analysis between the company's attitude to CSR and FRM

	Attitude to FRM	Attitude to CSR
Pearson correlation	1	-0.328**
N	161	154

Note: \*\* correlation is significant at the  $P < 0.01$  level (2-tailed).

Table 9 Regression analysis of the company's attitude to CSR and FRM

a. Model summary

Std. Error of the Estimate	$R^2$	Adjusted $R^2$
0.328(a)	0.108	0.102

b. Coefficients<sup>a</sup>

	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	5.097	0.427		11.923	0.000
Attitude to CSR	0.700	0.202	0.578	4.473	0.002

a. Dependent variable: Attitude to FRM.

Table10 Crosstab analysis between the occurrence of food safety incident and CSR performance

		Occurrence of food safety incident (OFSI)																				
CSR performance		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	17	18	19	21	32	Total
	1.0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
	2.0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
	2.5	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	3
	3.0	6	2	0	2	0	1	1	1	0	0	0	0	0	0	0	1	0	0	0	0	14
	3.5	2	1	2	0	0	1	1	0	1	0	0	0	3	0	0	0	0	0	0	0	11
	4.0	6	4	7	2	2	2	4	2	1	1	0	1	0	1	0	0	0	1	1	0	35
	4.5	5	3	9	3	2	1	4	0	3	2	1	2	0	0	0	0	0	0	0	0	37
	5.0	17	3	4	0	4	1	2	1	1	4	1	0	1	2	0	0	0	0	0	0	41
Total		39	13	23	7	8	6	12	4	6	7	2	3	4	3	1	2	1	1	1	1	144

Note: the higher the mark of CSR performance the lower the CSR performance (1.0 indicates the best CSR performance while 5.0 the worst).

Table11 Correlation analysis between effectiveness of FRM and the affecting factors

	OFSI	F1	F2	F3	F4	F5	F6	F7	F8	F9
OFSI	1									
F1	0.020	1								
F2	-0.090	0.057	1							
F3	-0.036	0.179	0.548**	1						
F4	0.214*	-0.059	0.177*	0.198*	1					
F5	-0.223**	0.091	0.271**	0.218**	0.114	1				
F6	-0.128	0.158*	0.271**	0.340**	0.141	0.476**	1			
F7	-0.189*	0.156	0.255**	0.339**	0.152	0.544**	0.879**	1		
F8	0.339**	-0.022	-0.201*	-0.305**	-0.069	-0.366**	-0.270**	-0.297**	1	
F9	0.086	-0.010	-0.131	-0.074	-0.044	-0.042	-0.138	-0.079	0.031	1

Note:

1. \*correlation is significant at  $P < 0.05$ , \*\* correlation is significant at  $P < 0.01$ .
2. OFSI is the occurrence of food safety incident, indicator of effectiveness of FRM;  
F1 means who is the decision maker of the company;  
F2 is the level of support the CEO gives to FRM;  
F3 is the changing trend of the level of support that the CEO gives to FRM in the last 5 years;  
F4 is the budget for FRM;  
F5 is the status of the FRM early warning system;  
F6 is the amount of trainings managers received regarding risk communication;  
F7 is the amount of trainings managers received regarding risk management;  
F8 is the importance of FRM for improving organizational behaviour;  
F9 is the change of profit in the previous 3 years.

Table12 Regression analysis of OFSI and its affecting factors

a. Model summary

SE of the Estimate	R <sup>2</sup>	Adjusted R <sup>2</sup>
0.433(a)	0.187	0.151

b. Coefficients<sup>a</sup>

	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	SE	Beta		
(Constant)	4.505	2.894		1.556	0.122
F4	0.204	0.066	0.265	3.079	0.003
F5	-0.585	0.552	-0.113	-1.059	0.292
F7	-0.800	0.624	-0.135	-1.282	0.202
F8	1.225	0.742	0.186	1.651	0.102

b. Dependent variable: F4, F5, F7, F8

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**FLOWER SECTOR COMPETITIVENESS: CASE STUDY OF A FLOWER SECTOR VALUE CHAIN IN KENYA**

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**ABSTRACT**

Kenya is concerned about the competitiveness of its flower industry. It is concerned about its ability to attract and retain investors in this sector as well as maintaining and growing its leadership in the export market. In this paper, we have used the value chain concept to analyze and determine the nature of the industry's competitiveness and identify areas of strength and vulnerability in order to provide information for policy makers and industry stakeholders. The value chain shows the linkages that exist between the various players in the business of flower production and flow of information from the market to the producers and vice versa. Value chain analysis has been applied to reveal the opportunities and challenges inherent in the flower business in order to improve performance through policy interventions and upgrading of chain activities in order to increase benefits accruing to the actors in the business in Kenya.

Two value chain analyses conducted in Kenya and Tanzania reveal details about the performance of the sector in the two countries and give us an opportunity to compare and contrast their performance. The comparisons reveal a number of similarities in the two chains as well as the differences. Overall in terms of gross margin percentages, the Kenyan value chain has an advantage over the Tanzanian value chain.

**CHAPTER ONE: INTRODUCTION AND BACKGROUND**

**1.1. INTRODUCTION**

Flowers are very important in human life. They could influence human feelings more than even words or gifts could do. They are applied in expressing love, sympathy, well wishes, etc. They are also used for decorations and beautification of both internal and external living and business environments. In Kenya, the government and key stakeholders of the sector are getting increasingly aware and concerned that the country's hitherto dominance in the production and export of flowers is no longer safe. Flower sector investors and buyers are now



spreading their activities to other countries in the region. In this paper, we discuss Kenya's flower sector value chain and try to understand its level of competitiveness using the Tanzania flower sector value chain as a benchmark.

This paper is intended to provide a discussion and analysis of the flower value chain in Kenya in order to identify aspects of competitiveness or lack of it in the sector in order to provide relevant information for policy making and upgrading. To appreciate the state of the competitiveness of Kenya's flower sector, we have collected data on a Tanzanian flower value chain for comparison. The paper is structured as follows: First, we provide as background, a discussion of the global flower business followed by details of Kenya's flower industry. The chapter will end with a discussion of the concerns about the competitiveness of the sector in Kenya and raise issues for research. Chapter two focuses on the survey of the available literature on value chain analysis and links it with competitiveness. Chapter three provides details of a flower value chain in Kenya and makes comparison with that of Tanzania. Chapter four is devoted to discussions on the findings in order to make the necessary conclusions.

## 1.2. BACKGROUND

### 1.2.1. THE GLOBAL FLOWER TRADE

Flowers are grown in more than 80 countries around the world and marketed and bought in virtually every place on the globe. The total size of the global flower trade is at least US\$40 billion with The Netherlands accounting for 56% of the exports. Other top exporting countries are: Colombia (16%), Ecuador (6%), Kenya (4%), Zimbabwe (3%) and others (15%). See figure 1.1 below:

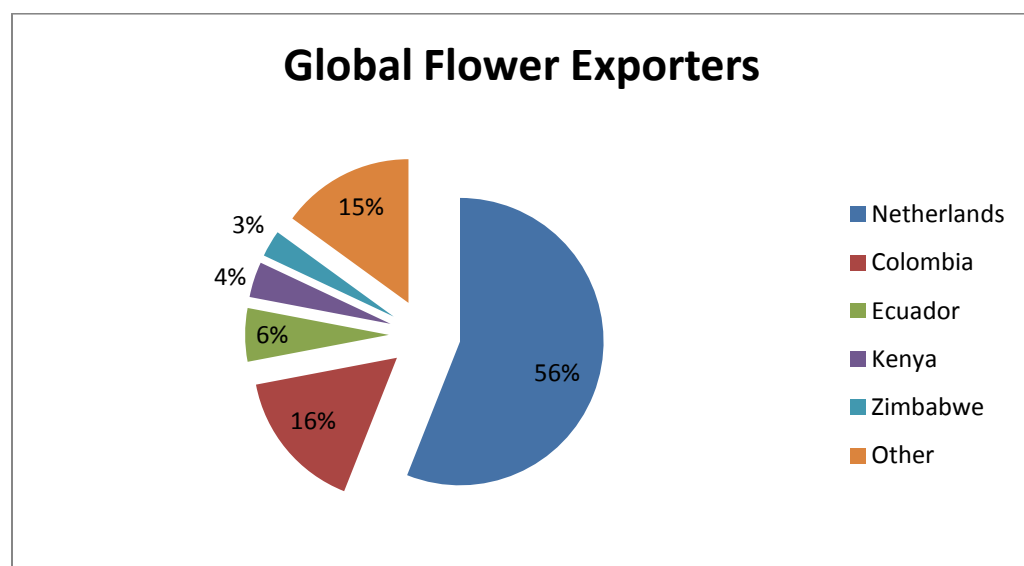


Fig. 1.1: Global Flower Exporters (Source: Comtrade 2009)

Globally, Kenya ranks number one in flower exports into the European Union. As of the year 2007, the country accounted for 39% of cut flower imports into the EU followed by Colombia (14%) and Ecuador (13.6%). See table 1.1 below.

**Table 1.1 Top 10 cut-flower exporters into the EU market**

2001			2003			2007		
country	share in EU market	Rank	country	share in EU market	Rank	country	share in EU market	Rank
Kenya	25.90	1	Kenya	31.71	1	Kenya	39	1
Israel	18.35	2	Colombia	15.15	2	Colombia	14.17	2
Colombia	15.40	3	Israel	14.08	3	Ecuador	13.6	3
Ecuador	12.10	4	Ecuador	11.15	4	Israel	8.94	4
Zimbabwe	10.04	5	Zimbabwe	8.69	5	Ethiopia	5.05	5
Thailand	2.84	6	Thailand	2.71	6	Zimbabwe	2.82	6
Zambia	2.67	7	Uganda	2.66	7	Uganda	2.56	7
Uganda	1.87	8	Zambia	2.61	8	Thailand	2.52	8
South Africa	1.60	9	South Africa	2.24	9	Zambia	1.96	9
Tanzania	1.45	10	Turkey	1.67	10	South Africa	1.62	10
<b>Ethiopia</b>	<b>0.14</b>	<b>24</b>	<b>Ethiopia</b>	<b>0.50</b>	<b>15</b>			

Source: UN-Comtrade

Importing countries are mainly European and the USA though Japan is increasing in prominence as per 2005 figures. The major ones are as follows: Germany (16%), UK (11%), USA (11%), France (9%), Netherlands (9%), Italy (4%), Japan (3%), Switzerland (3%), Russia (4%), others (20%).

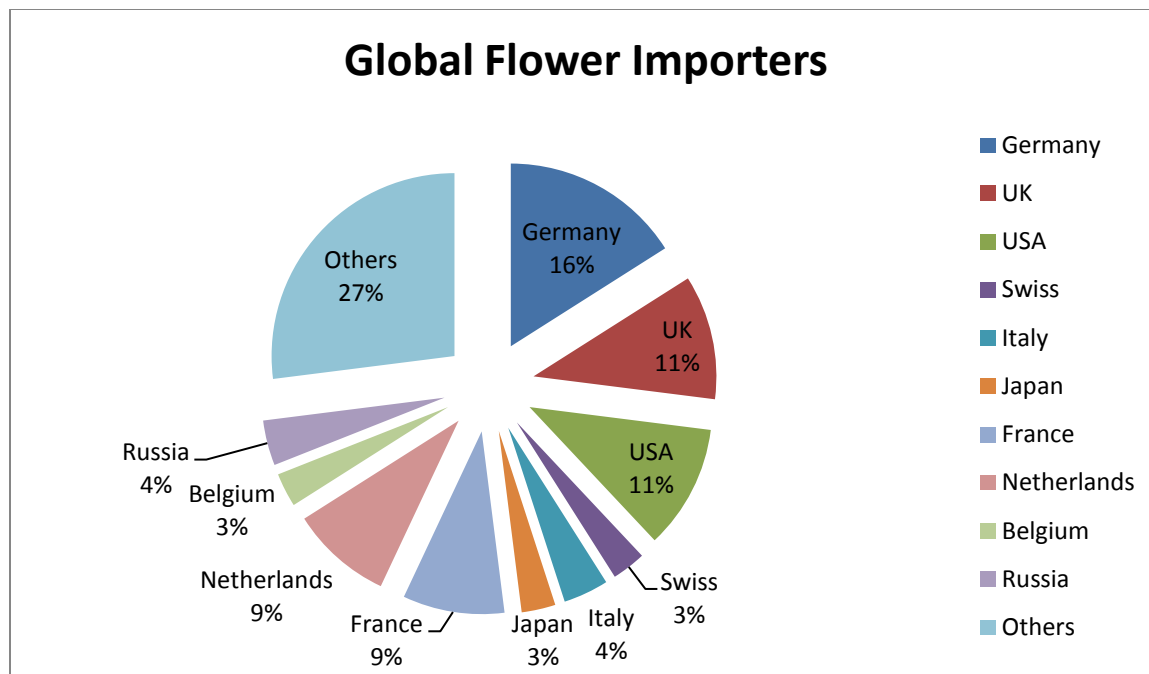


Fig. 1.2: Global Flower Importers (Source: Comtrade 2009)

The flower farming and export industry is experiencing tremendous growth in Africa. A number of the Sub-Saharan African countries are now becoming major exporters of this commodity to Europe and to other emerging flower markets around the world. This is shown in figure 1.3 below.

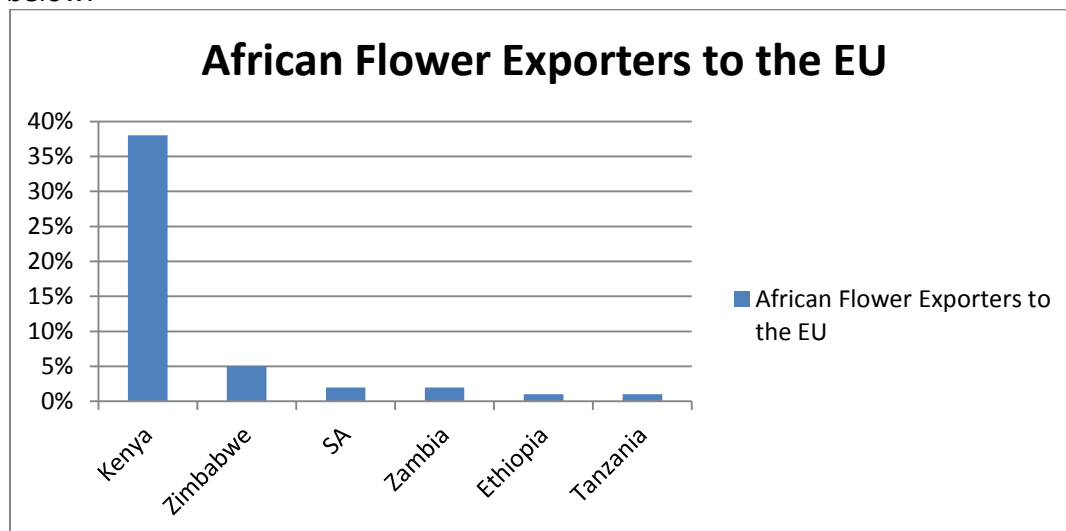


Fig.1.3: African Flower Exporters-Source: EUROSTAT Database (2007)

### 1.2.2. KENYA FLOWER INDUSTRY

Flowers are grown in many parts of the country as shown on the map below.

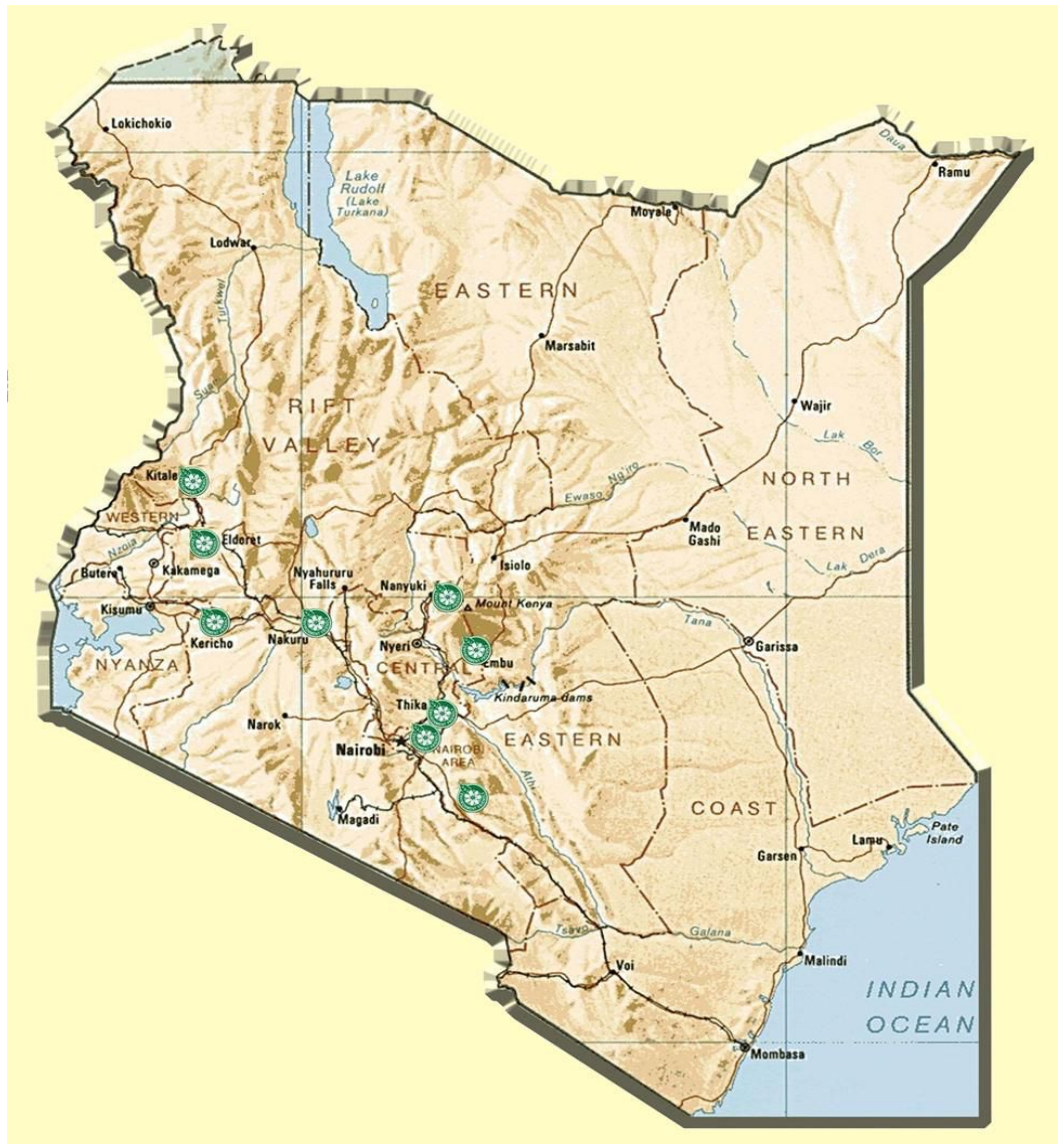


Fig.1.4: Map of Kenya (Flower Growing Areas)

Kenya is one of the leading producers and exporters of cut flowers in the world. In 2007, flower export earnings were US\$600 million, a growth of 79% over the year 2006 figures (Kenya Flower Council-2007). The industry employs 100,000 people directly and 2 million indirectly. The major export market is the European Union where Kenya commands a 38% of the market share. Within this market, The Netherlands takes 65% of Kenya's flowers whereas 25% is sold to Britain, 8% to Germany and 2% goes to other markets. Roses account for 70% of Kenya's flower exports. There are approximately 5000 flower growers in Kenya.

97% of the flower export is by large scale companies mostly owned by foreigners. This dominance is explained by the high capital and knowledge nature of the market. On average, an investor requires at least US\$50,000 per hectare to start a flower farm. On top of this, there are the operating expenses and vigorous marketing abroad. The only choice the small growers are

left with, therefore, is the open field summer flower farming practice which or as contract farmers for the large scale exporters.

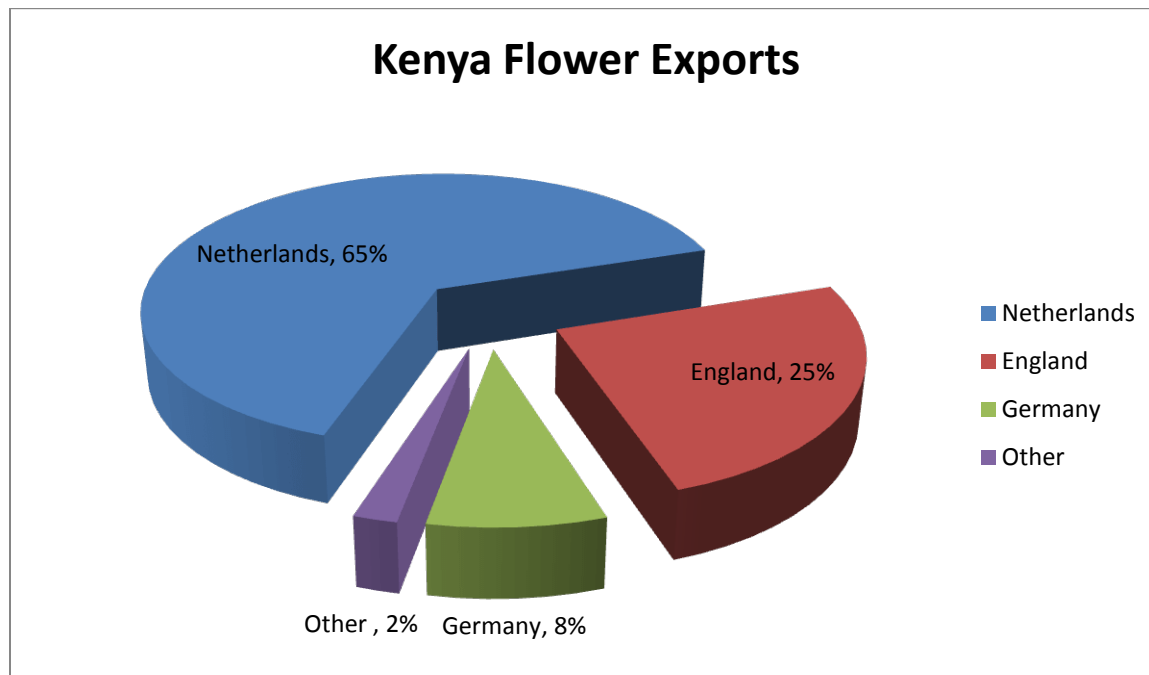


Fig.1.5: Kenya Flower Exports-Source: Kenya Flower Council

Table 1.2: Kenya's Flower Exports

Year	Volume (Kg)	Value (million \$)	Change (%)
2003	60,982,885	223	
2004	70,666,260	253	13%
2005	81,217,831	309	22%
2006	86,480,002	319	3%
2007	91,192,726	573	79%
2008	118,626,644	480	-16%
2009	120,394,968	464	-3%

Source: Kargbo, A, J. Mao, C. Wang (2010)

However, despite Kenya's good performance in flower production and export, there is increasing concern about the sustainability of the competitiveness of the country in this sector. Various stakeholders in this sector have expressed concern that Kenya seems to be losing its competitiveness edge in flowers. This paper will address this question using the value chain approach. Through value chain analysis the paper aims at identifying aspects of competitiveness or otherwise in the sector and benchmark the same with a similar value chain analysis conducted in Tanzania.

## CHAPTER TWO: LITERATURE REVIEW

### 2.1. INTRODUCTION TO VALUE CHAINS

A value chain is the sequence of activities required to make a product or provide a service to the final consumer (Schmitz, 2005). Kaplinsky and Morris (2000) have also defined a value chain as the full range of activities required to bring a product or service from conception, through the different phases of production, delivery to final consumer and disposal after use. Gereffi, et al (2005), in their definition, state that the global value chain is the different ways in which global production and distribution systems are integrated. However, Memedovic (2008) has tried to extend this definition to include inputs on the one hand and even recycling on the other. She says, "The value chain perspective captures the sequence of related activities required to bring a product or service from material inputs to production, marketing, sales, final consumption, after sales service and eventually recycling." She ascribes the proliferation of global value chains to technological change, organizational innovation and policies of liberalization and deregulation in trade and investment. She says these have allowed for functional fragmentation of value chain tasks into distinct units in some value chains and for outsourcing these tasks to capable producers worldwide. Gereffi et al (2005) add that the key issues in the value chain literature are which activities and technologies a firm keeps in-house and which ones should be outsourced to other firms, and where the various activities should be located. Therefore, a value chain describes the linkages that exist among the actors involved in the production, distribution and selling of a product.

Value chain analysis involves identifying and mapping the relationships of four types of features (World Bank-2007):

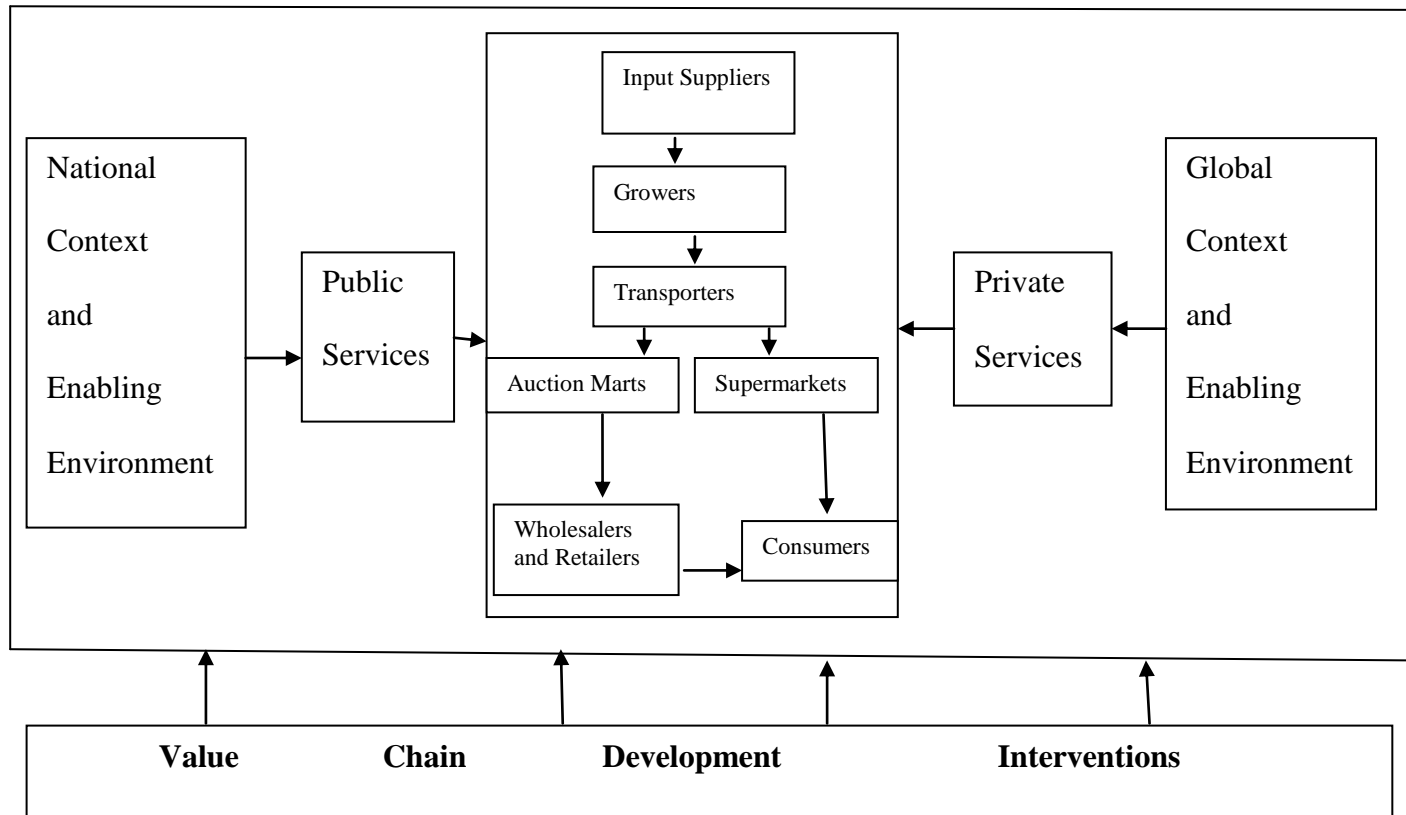
- The activities performed during each stage of processing.
- The value of inputs processing time, outputs and value added.
- The spatial relationships such as distance and logistics of the activities.
- The structure of economic agents such as suppliers, the producer and the wholesalers.

Value chain analysis will help in identifying the determinants of competitive advantage and the influences that determine the sharing of value among the various actors within the linkages along the chain. According to Kaplinsky and Morris (2000), value chain analysis, by concentrating on the inter-linkages among actors and activities, allows for an easy uncovering of the dynamic flow of economic, organizational and coercive activities between producers within different sectors and even on a global scale. By focusing on the links on the chain, the activities, actors, the value produced and how it is shared along the chain, helps to identify opportunities for policy interventions in order to improve chain performance and governance. It is an analytical tool that helps in understanding the policy environment for efficient allocation of resources both at the local economy level and globally.

For a generic flower value chain, figure 2.1 shows the links and major actors that influence the performance of the chain. The national context refers to the government and its institutions and agencies that develop policy and the legal and regulatory framework for facilitating the growth and development of the flower sector in Kenya. It provides an enabling environment through provision of public services which the flower firms and the providers of support

functions required to conduct their business. The internal context facilitates the development of internal infrastructure in terms of roads, water and electricity. The global context refers to the international agencies and institutions that formulate policy and regulatory framework for flower trade. It provides an enabling environment for the private sector and gives support to the flower value chain in terms of services such as training, consultancy, technology, etc.

Figure 2.1: Generic Flower Value Chain (Source: *Modified, UNIDO, 2009*)



## 2.2. VALUE CHAIN GOVERNANCE

### 2.2.1. DEFINITION

Value chain governance involves the definition and enforcement of instructions relating to the various stages of the chain. First is what products are to be produced. This includes product design and specification. Secondly, how they are to be produced. This involves the definition of the production processes, which can include elements such as the technology to be used, quality systems, labor standards and environmental standards. Thirdly, how much is to be produced, and when. This refers to production scheduling and logistics (Humphrey-2006).

### 2.2.3. TYPES OF CHAIN GOVERNANCE

There are a number of different types of chain governance. They could be classified into five main groups as follows according to Gerefi et al (2005):

- **Markets.** This is where the transactions take place at arm's length and neither buyers nor suppliers exert any influence over the other. It occurs where transactions are easily codified, product specifications are simple and the suppliers are capable and do not need assistance from buyers. Here asset specificity is absent. In the flower trade, direct sales in the Dutch auction markets falls in this category.
- **Modular.** In this case suppliers are competent and the information on the product and production processes can be codified. The product is complex and can be disaggregated into many components which can in turn be recombined into many product variations. In this case, a buyer can source from different suppliers or one large supplier can source from many small producers to sell the lead firm. The European supermarkets and the various flower farms that supply them with flowers of different varieties could be said to be operating a modular relationship. Research done in Ethiopia has shown that successfully competing in the global buyer dominated markets requires higher capability at the supply base to ensure a consistent, diversified and quality product that complies with regulatory requirements (Gebreeyesus and Sonobe, 2009).
- **Relational.** Here the interactions between buyers and suppliers are more complex and leads to mutual dependence and high levels of asset specificity. Knowledge is normally non-codified and both suppliers and buyers have specialist knowledge that the other does not possess. These linkages often take the form of strategic alliances (Humphrey-2005).
- **Captive.** Here, small suppliers are transactionally dependent on much larger buyers. Suppliers face high costs of switching from one buyer to the other and therefore are "captive". The lead firm exercises a high degree of monitoring and control.
- **Hierarchical.** This is basically vertical integration and the supplier is a subsidiary or affiliate of the buyer. Control flows from manager to sub-ordinate or from headquarters to subsidiary or affiliate.

The governance types observable in the flower market are limited to two. One is the arms-length market and the other is modular. In the market type transactions are less complex, market information is easily accessible, prices are transparent, and costs are easily obtainable. An example is the flower auction mart. On the other hand, direct sales to the supermarkets require a large variety of flowers in small volumes. They strictly apply different standards that make the transaction more complex. They also involve complicated codification of information.

#### 2.2.4. VALUE CHAIN GOVERNANCE AND FIRM COMPETITIVENESS

The global value chain would help in determining the competitiveness of the firms in the sector through linkages with the global markets. The local flower producer is connected with the supermarket chains in Europe who have access to the global buyers. This linkage and the ability to meet the needs of the retail chains, gives the local producer a measure of competitiveness. Schmitz (2005) says that the global value chain can help local enterprises and the institutions that support them to engage in a process that helps them to participate in the global economy in an informed and gainful way. This is particularly evident in a captive chain which provides opportunities to upgrade production capabilities. The lead firms are normally demanding in



terms of reducing costs, raising quality and increasing speed, which at the end of the day enhances the performance and hence the competitiveness of the local firm.

## **2.3. VALUE CHAIN UPGRADING**

### **2.3.1. NATURE OF UPGRADING**

As partners in the value chain transact with each other, the result may be such that due to competitive forces, one side of the partnership may come out better off and the other worse off. Kaplinsky (2000) uses the term “immiserising growth” to imply that the losing party may experience growth in volumes but see a decline in revenue. This means that what the losing party is getting is less and yet they are giving more. The solution to this situation may be innovation, but then Kaplinsky says that innovation in the face of increasing competition may still lead to immiserising growth. Therefore the solution is upgrading. Upgrading means innovation that is faster than that of the competition. It recognizes the relative endowments and hence the existence of rent (Kaplinsky-2000).

Studies have shown that the linkages of firms on the global value chain provide an opportunity for local firms in an industry to upgrade their capabilities and become more competitive. A study by UNDP (1988) concluded that buyers are more effective in transmitting the capabilities required by local firms to compete in distant markets than publicly funded business development services. Another study, which was about Business Development Services for small enterprises in Thailand and Vietnam, concluded: “Services provided through the business relationships were the most prevalent and diverse services in both countries” (Anderson, 2000). This means that trading relationships contribute more to upgrading of small enterprise capabilities than stand alone services.

Recent studies on value chain analysis have discussed various approaches used by buyers to help local producers upgrade their processes and products (Gereffi, 1999, Humphrey and Schmitz, 2004, Nadvi and Thorburn, 2004, Schmitz and Knorringer, 2000). Buyers want the product produced to the right specification, at the right time, in the right place to eliminate the “risk of supplier failure”. The buyers play a dual role: They are extremely demanding such that they put pressure on the producer to work hard and innovate. Secondly, they provide assistance so that these demands are met. They also monitor the local producers constantly to expose possibilities of failure and show how the failures could be rectified. Fromm and Dubon (2006), writing on coffee value chains in Honduras, say that buyers in the developed countries coordinate and monitor their suppliers in the developing world partly because of lack of trust but mostly because of cost and quality issues. Here, suppliers are expected to respond with competence in performing the tasks required. Those that are not considered competent may require more supervision through standards or they risk losing a contract.

### **2.3.2. TYPES OF UPGRADING**

There are two different schools of thought relating to upgrading according to Kaplinsky. The first one focuses on core competence and is espoused by Hamel and Prahalad (1994). They focus on the firm's competences to determine those of its attributes that:

- Provide value to the customer.
- Are relatively unique in the sense that few competitors possess them.
- Are difficult to copy meaning there are barriers to entry.

They say that the capacity to innovate therefore arises from concentration in these competences and then outsource those functions which do not meet the stated criteria.

The second school of thought focuses on dynamic capabilities and was conceived by Teece and Pisano (1994). The concept argues that a firm's performance cannot be sustained in the long run by exercising control over the market but through development of dynamic capabilities as follows:

- Building internal processes which facilitate learning, including capacity to configure what the firm has done in the past.
- The ability to access specific competences either within a firm's own activities or those which are drawn from the regional or national system of innovation.
- Taking a trajectory that embraces change.

Much as the two schools of thought give us an indication as to the source of upgrading for the firm, they leave out systemic factors which involve groups of factors linked together in a chain.

Upgrading therefore, must focus on bringing change in the nature and mix of activities, both within each link in the chain, and in the distribution of inter-chain activities. Upgrading involves developing new products and processes and the functional reconfiguration of who does what in the chain as a whole.

### **2.5. MACROECONOMIC POLICY INTERVENTIONS FOR CHAIN COMPETITIVENESS**

Value chain analysis provides an opportunity to identify business environment constraints which will enable policy makers to come up with appropriate macroeconomic policy reform processes that will focus on priority areas along the product value chain. It will provide a basket of tools to enable the policy maker to identify the position issues and options available to address the specific challenges facing a given sector. This will assist in creating a strong business environment based on sound institutions and policies which is a necessary basis for enhancing competitiveness of private firms that produce and deliver goods and services (World Bank, 2005).

Kaplinsky and Steadman (2008), have identified three levels of policy support to facilitate upgrading of the value chain. The first policy level represents a series of financial policies to improve market performance in order to make financial intermediation less costly, more

transparent and equally available to all strata of the economy. In this group of policies is the promotion of a stable economic environment in terms of exchange rates inflation and interest rate. Exchange rates will also help in enhancing global completion.

The second group of policies proposed is what they called horizontal policies and are targeted at generic market failures. They include investments and promotion of R&D, training and provision of infrastructure. And the third are a group of selected policies designed to promote the advance of particular sectors or particular firms. These relate to an incentive regime to promote productivity in the sector, support for sectoral research and technology organizations and the encouragement of specialized producer services sector.

In addition, Kaplinsky and Morris (2000) have proposed the following policy interventions that are designed to facilitate sector value chain upgrading:

- Assisting firms to acquire new competencies in order to take on activities or functions associated with being located elsewhere in the value chain. Governments to facilitate firms to upgrade their knowledge intensive process competencies and then firms can shift into other sectors/value chain after acquiring them.
- Governments can foster the resource development and capacity expansion of the national system of innovation to raise the general knowledge intensive environment from which firms draw their resources and within which they operate.
- Overall macroeconomic management effort aimed at maintaining a stable economic environment such as a stable and realistic exchange rate, low inflation and interest rates.
- An educated and skilled labour force.
- Realistic policies to encourage investment, appropriately defined corporate and property laws, as well as a social and political environment commensurate with sustainable and stable accumulation.

In conclusion, policy issues can be classified into four main areas according to World Bank (2007). This is illustrated by figure 3.2 below. There are those policies that will require implementation by the public sector and will have economy wide implications such as macroeconomic stability, land, infrastructure and even investment policy. Then there are those to be implemented by the public sector but will affect only a targeted sector Such as tariff removal, FDI and import licenses. There are also those policies to be implemented by the private sector but with economy wide implications. Examples are privatization of such services as water, roads and power. Finally, we have those policies that will be implemented by the private sector and their impact will be limited to a specific sector, such as provision of certain aspects of infrastructure, FDI, etc.

### **3.0. METHODOLOGY**

The research work for this paper has relied on both primary and secondary data. Primary data has been collected on two value chains, one in Kenya, the Manoa Farm and the other in

Tanzania, Mount Meru Flower Farm. The data captures the sequencing of the activities as well as data on volumes, revenues and costs. Information has also been obtained regarding the players on the value chains and the roles they play.

The primary data was collected through face to face personal interviews using a prior prepared checklist of questions. In both cases, I interviewed the general managers of the farm. I also had the opportunity of going around the farms and physically observing on how the process of flower business is carried out at farm level.

Secondary data has been obtained from relevant literature on the main concepts of value chain..

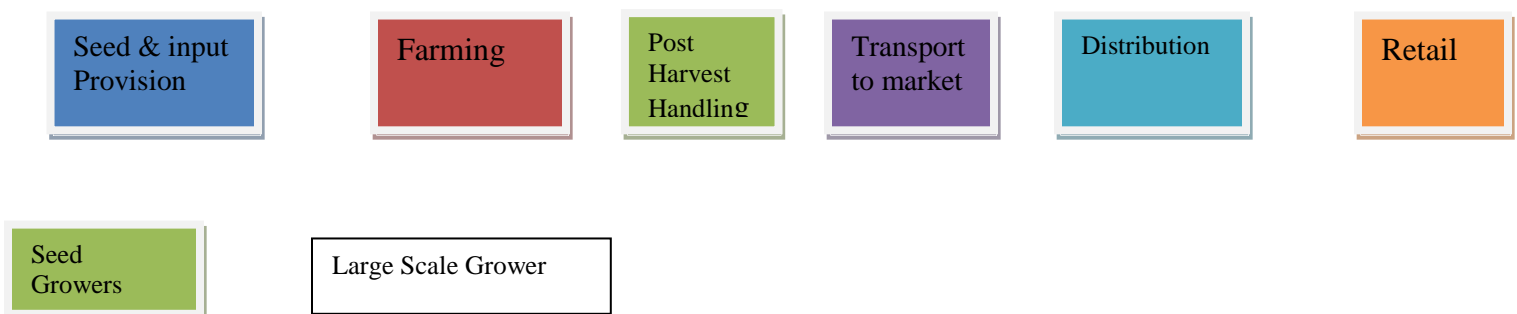
#### 4.0. THE VALUE CHAINS

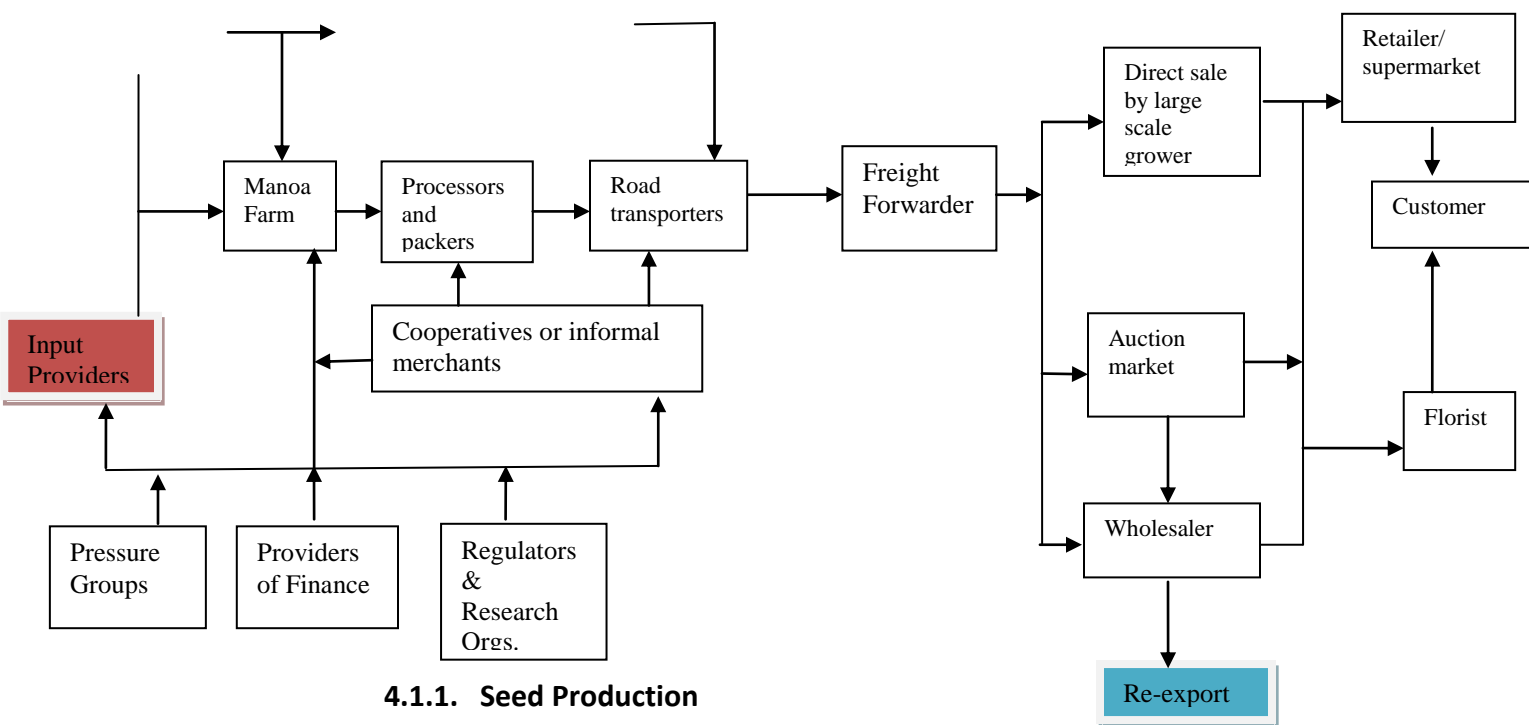
Here we analyze two value chains, one from Kenya and the other from Tanzania. The Kenya value chain is for a flower farm, Manoa (not its real name), located in Nairobi and producing mainly roses for export to the European markets. The Tanzania value chain is for a flower farm, Mount Meru Flowers, located in the outskirts of the city of Arusha and producing mainly roses for the European market. In some ways these farms operate in more or less similar climatic and economic conditions but there are many factors that differentiate them and hence determine the differences in competitiveness.

##### 4.1. KENYA FLOWER FIRM VALUE CHAIN (MANOA FARM- 13.5 HA).

The value chain presented here below is for Manoa Farm. This is part of a larger group called Manoa Roses. Manoa Roses group owns four flower farms: Manoa (13.5 ha), Manoa Kericho (23ha) and two farms in Molo with a total acreage of 42 hectares. Manoa Roses is owned by a group of indigenous Kenyan investors. Manoa Farm is located in the Karen area of Nairobi, a distance of roughly 19 kilometers from the centre of the city. The farm specializes in rose farming and export. It has a total acreage of 13.5ha. With a total turnover of US\$2.68 million, Manoa employs around 200 people most of whom are casual laborers who are paid an average of US\$2.50 per day. The farm grows rose flower in greenhouses and exports 75% of them through the Dutch flower auction market. The rest are sold directly to buyers in the UK, Sweden, Russia and Japan.

Fig.3.1: Manoa Farm Value Chain

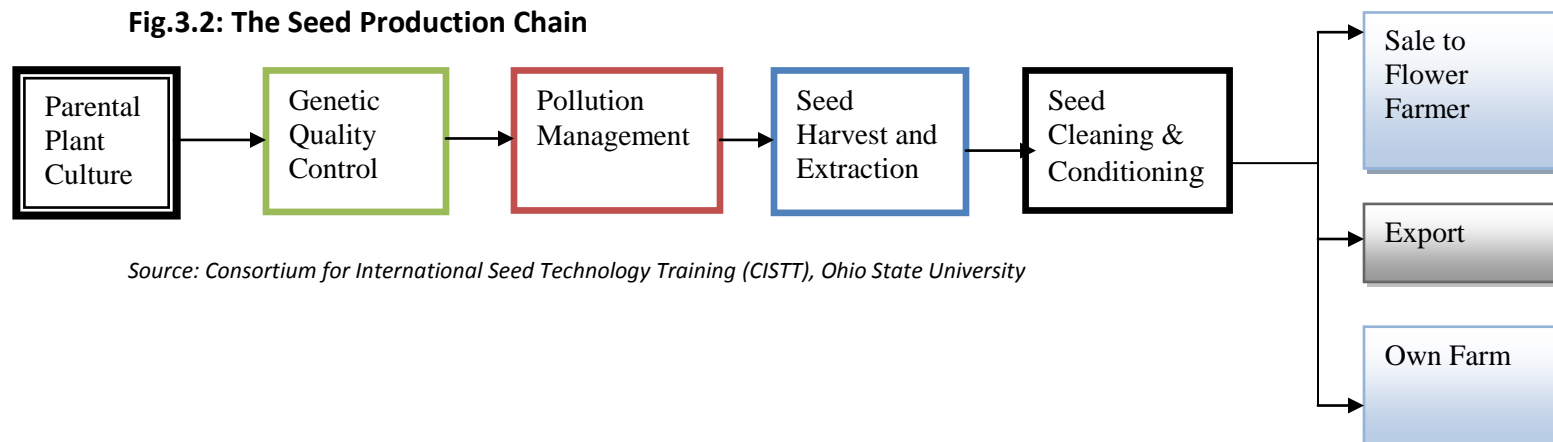




There are three main routes through which flower farmers in Kenya get seeds. One is by breeding the seeds themselves. Two is direct purchase from breeders and third is importation.

Seed production is a technology intensive exercise as shown in the chain below (Fig.3.2.)

**Fig.3.2: The Seed Production Chain**



Manoa Farm obtains its seedlings from breeders at an average cost of 30-32 Euros per square meter. Annual royalties paid to the breeders for the plants is 0.8 - 1 Euro per square meter or 0.2 Euro per plant per year. The main breeders who supply Manoa are located in Nairobi and Naivasha which is roughly 90 kilometers away. Some of these are: Kordes Roses, Lex, Shreurs, Olij and Deureter. All these are local but foreign owned. Although the plants are costly, Manoa must continue to source them from qualified breeders in order to maintain quality and retain market share. Customers in Europe are particular about the quality of the seeds used to produce the flowers.

#### 4.1.2. Input Supply

There are various inputs that Manoa requires and uses. We have already talked about seedlings or plants as they are commonly called. Other inputs are the greenhouses, water, fertilizers, chemicals and packaging materials and the cost of land.

**Greenhouse materials** are imported from Israel and they cost on average US\$11 per square meter which includes purchase and annual maintenance. The materials have an economic useful life of 7 years on average. However, the polythene is changed after every three years. The depreciation charge is included in depreciation expenses shown under other expenses caption below.

The **chemicals** used are mainly pesticides meant to control pests and weeds. Manufacturers of these chemicals are mainly multinational corporations with production facilities and distribution agents locally. The major manufacturers are: Bayer, Syngenta and BASF. Their local distribution agents are: Amiran Kenya, Elgon Chemicals, Twiga Chemicals, Osho Chemicals and Farmchem among others. Chemicals are costly. Manoa consumes on average US\$1 of chemicals per square meter per year. In total per year, cost of chemicals for Manoa amounts to US\$92,000 per year or 3.4% of total revenue.

**Water** is obtained from rain harvesting, boreholes and the Nairobi Water Company. Consumption averages 60 cubic meters per hectare per day which amounts to roughly 171,000 cubic meters per year. The total water and electricity bill amounts to US\$78,500 or 2.9% of total revenue.

**Fertilizer.** Over the past one year, it has gone up by an average of 75%. Its consumption averages US\$1 per square meter per year which is at the same rate as for chemicals. The Farm spends roughly US\$100,000 on fertilizer per year which is about 3.5% of total revenues. It is procured from Amiran Kenya, Twiga Chemicals and Ocean Agriculture.

**Land** is US\$600,000 per hectare on freehold.

Other production expenses include repairs, maintenance and motor vehicle running expenses which amount to US\$85,000 or 3.2% of the total revenue. Labor costs amount to US\$586,000 or 22% of total revenue. The depreciation of the capital equipment amounts to US\$ 180,000 or 7% of total revenue. Other general expenses such as office expenses, telephone and email, etc amount to US\$92,000 or 3.4% of total revenue.

**Table 3.1: Production Expenses Summary**

ITEM	Cost %age
Labor	22%
Water & Energy	2.9%
Fertilizer	3.5%
Chemicals	3.4%
Repairs & Maint,	3.2%

Depreciation	7%
General Exp.	3.4%

#### **4.1.3. Postharvest**

These are all those activities that are required to get the flowers ready for export. This function is greatly influenced by the major European buyers especially the UK supermarkets. Post harvest starts immediately after harvest and then the flowers must be sorted, cleaned and graded. After this, the flowers must be inspected to ensure that they meet the required standards. Packing is done to ensure the flower is well protected for freighting and ready for the shelves in the supermarkets. The firm spends a total of US\$110, 000 on packaging. This is about 4.1% of total revenue. Packaging materials are obtained locally from: Prestige Packaging, East Africa Packaging, Carton Manufacturers and Prime Carton

Transportation is done in refrigerated trucks to ensure the flowers are kept in low temperatures so that they are not damaged. Manoa uses own trucks but the cost is minimal as the airport is less than 25 kilometers away. The cost is part of Repairs, Maintenance and Motor Vehicle running expenses already discussed above. The flowers are maintained at a temperature of between 2-4 degrees Celsius. They must arrive within 4 hours of the aircraft departure. Transportation, airfreight handling and freighting are done mainly at night when the temperatures are comparatively low.

#### **4.1.4. Transport to Market**

Flower transport is a large component in the production cost of flowers. In Kenya, it averages one US cent per stem. Most large scale farmers have invested in sophisticated post-harvest cold supply chain infrastructure including refrigerated trucks. 90% of Kenya's flowers are handled by specialized air freight forwarders, three of which are owned or linked to top flower producers (World Bank-2005). The steps involved in this stage include customs clearance in Nairobi, inspection, cargo handling and then freight to destination. The cargo must be booked for clearance a week in advance. All these have to be done expeditiously to avoid long storage time at the airport. Ideally, all the functions are performed within four hours of the flower arriving from the farm to ensure quick dispatch to the market. As for Manoa, freight costs a total of US\$400,000 or 15% of total revenue.

#### **4.1.5. Distribution**

On arrival at destination points, the flower consignment is subjected to inspection by customs and health officials before being released to the distribution outlets. There are four main channels of distribution: the auction floor, the wholesalers, the supermarkets and the florist shops. Manoa sells most of its flowers (75%) through the flower auctions and 25% to the supermarkets, wholesalers and other direct clients. Some of the wholesalers re-export flowers,

after purchase from the auction marts, to the rest of Europe, the USA and Japan. Total selling and distribution expenses of Manoa Farm amount to US\$241,000 or 9% of total revenue.

#### **4.1.6. Other Actors.**

##### **i. Freight Forwarders**

Manoa uses own cooling trucks to transport their flowers to the airport. They do their own papers. The flowers are checked by representatives of Kenya Plant Health Inspection Services (KEPHIS) and then handed over to the freight handlers. Three main handlers operate from JKIA in Nairobi: Durflo, KN and Total Touch. Manoa uses any of these. These are the people who organize for freighting. They also take care of cooling and storage at the airport.

##### **ii. Cooperatives and Informal Merchants.**

Small growers in the industry who are unable on their own to organize for export have to form cooperatives in order to afford the various related expenses. Alternatively, they do sell their produce to merchants who are not growers but operate as middlemen. Manoa operates on their own, but on certain activities like transport and clearing, they would share facilities and staff.

##### **iii. Large Farmers.**

The large scale farmers control roughly 90% of the flower exports in Kenya. There are about 40 of them who share this volume. On the other hand, about 4,500 small producers share the remaining 10%. Some of these have sister companies who do direct selling abroad on their behalf.

##### **iv. The Dutch Auction Market**

Manoa sells 75% of their flowers at this market. The auction has its own rules which everyone must follow and the price is a function of the forces of supply and demand for any given day. Each seller must pay auction commission and other auction costs. Manoa spends a total of US\$119,000 on these two items per year.

##### **v. Supermarkets**

The supermarkets in Europe take up the remaining 25% of the flowers produced by Manoa. Manoa exports flowers to the supermarkets in the UK and the mainland European countries like Germany and Italy. These markets have done a great deal in not only developing the flower market, but also in operating as a link with the final consumer. They are able to know what the consumer wants and then communicate the same to the producer.

##### **vi. Providers of Finance.**



There are many institutions that provide finance for this sector. Manoa has been financed long-term by the shareholders and a development finance institution. Other banks as well have provided both short and medium finance.

#### **vii. Regulators and Research Organisations.**

There are many organizations whose main occupation is to ensure fair practice among the various players in the industry. Examples are The Kenya Flower Council (KFC) which is a members' organization catering for the interests of the member flower farms and the Fresh Produce Exporters Association of Kenya (FPEAK) that covers the wider Horticultural sector. There are also agricultural research organizations like the Kenya Agricultural Research Institute (KARI) providing useful support in terms of new flower varieties and new ways of crop husbandry. The Kenya Plant Health Inspectorate Services (KEPHIS) as well plays a crucial role in ensuring that the seeds and flower plants imported and exported are free of diseases.

#### **4.1.7. SIMPLIFIED GROSS MARGIN**

The total cost, as a %age of total revenue, of flowers from farm to market could be summarized to three items as follows:

Production	45.4%
Packaging	4.1%
Transport & marketing	24%

Manoa Farm gets a Simplified Gross margin amounting to 26.5%.

#### **4.2. CHAIN GOVERNANCE**

The governance of the chain can be described as partly market and partly modular. Since a large portion of Manoa's flowers (Seventy five percent) are sold through the Dutch auction mart, it means therefore to that extent, they are in a market form of governance. The auction mart is an open market whereby the highest bidder gets the deal and no party is able to exercise control over the other and the product is more or less standard. On the other hand, the firm sells twenty five percent of its flowers to supermarkets in Europe and the UK. These supermarkets are the outlets for the form's flowers and have information about what the customer wants about flower quality quantity timing and packaging. They set the standards that must be followed by Manoa and in addition provide a ready market for the product.

Another aspect of modular linkage for Manoa is with input providers. On the downstream, the firm has linkages with seedling, fertilizer, chemical as well as packaging and greenhouse materials producers. Manoa needs to get the correct inputs, especially seedlings in order to meet the quality requirements of the customers as communicated by the supermarkets.

#### **4.2.1. HOW MANOA'S COMPETITIVENESS IS ENHANCED BY THE GOVERNANCE LINKAGES**

Manoa benefits a lot from the linkage with the supermarkets. The supermarkets provide information on what the customer wants in terms of quality and quantity. The supermarkets also insist on strict adherence to the set standards especially the Kenya Flower Council silver standards. The supermarkets also insist that flowers are grown using high quality and branded seed varieties. The supermarkets also guarantee a market. Manoa need not struggle to seek customers in Europe. The supermarkets have a ready outlet. All these give Manoa a competitive edge over competitors who are not on the same chain.

Manoa has also benefitted from the modular linkage as some of the markets transfer some of their functions upstream and therefore provide Manoa with an opportunity to upgrade their processes. Some of the supermarkets prefer to receive flowers which are ready for the shelf and therefore have allowed Manoa to do the packaging for them.

Sale through the auction mart also has its own advantages. The market provides a ready market where Manoa goes to sell its flowers. The market set up gives Manoa an opportunity to get the best price for the flowers that the market can give. The competitive environment in the market puts pressure on Manoa to improve on the quality and presentation of the product.

#### **4.3. OPPORTUNITIES OPEN TO MANOA FARM.**

There are many opportunities open to Manoa in the flower business. First, the domestic flower market is virtually untapped. The Kenya Flower Council is currently trying to promote this market through business skills support for local vendors. This is what Manoa could emulate. Secondly, there are other untapped markets for flowers in countries like Japan, Russia, Poland and the Middle East. Planned direct flights from Nairobi to Japan will enable direct sale of Kenya flowers to Japan instead of passing through Europe.

Related to the above, new auction marts have opened in Dubai and Mumbai which presents a great opportunity for the Kenyan producer. These cities are closer to Kenya and could be cheaper inspite of the heavy competition Manoa might face from sellers from India, China and Sri Lanka.

The increasing role played by the supermarket in Europe in the flower business also presents an opportunity as it is expanding demand for flowers as well as helping the farmer in reaching the market without spending money in marketing. The linkage with the supermarket frees Manoa from marketing and customer care to concentrate on flower farming, packaging and transportation.

The good trade relationships that exist between Kenya and the EU have benefitted flower farmers who enjoy preferential status in exporting flowers to the region. Recently, Kenya has

signed a multilateral agreement, with the EU, called the Economic Partnership Agreement (EPAS). The agreement gives Kenya duty free access to the EU markets.

Other opportunities available include availability of certification opportunities to ensure compliance to market requirements hence increased access. The stability of the Kenya shilling also means that any investment made in Kenya will be safe and also allows for companies to plan for the future. There is abundant and well educated skilled labor force. Nairobi is an air transportation hub and it is easy to get flight connections to many parts of the world from here. Road, telecommunication, power supply and other infrastructural facilities are well developed. There are adequate cooling facilities at the airport to preserve the flowers while being cleared for freighting. Nairobi is a high altitude location and the cool weather provides a favorable environment for flower export business.

#### **4.3.1. THE CHALLENGES TO THE FARM'S BUSINESS.**

However, there are many challenges that Manoa is facing currently. For example, the firm sells 25% of its flowers to supermarkets in Europe but these organizations make it quite difficult for small flower growers like Manoa to remain in business. The supermarket wants to deal with members of the Kenya Flower Council, but the conditions to be a member are that you must adhere to their code, which only large growers can afford. The Kenya Flower Council Silver code is very stringent and expensive to meet.

Recently, flower exporters from developing countries have started receiving pressure from environmental activists. The most serious one is the carbon miles where it is being said that flower transportation emits carbon into the atmosphere. It is said that the longer a commodity is transported by air, the more carbon is emitted and therefore the more polluted the environment gets.

Manoa also faces challenges related to a host of Non-tariff barriers the industry is subjected to. For example, for Manoa to sell its flowers abroad, it must meet the following standards and controls:

- Phytosanitary (Plant health) control.
- Breeders' rights and intellectual property.
- Quality and grading standards.
- Labeling requirements.
- Trade related environmental and safety standards.

- The convention on International Trade and Endangered Species (CITES) and other regulations on trade.

In flower farming, pests and weeds are a menace. They must be controlled and it could be very expensive and could even wipe out profits. There is the environmental and safety implications in terms of the types and quantities of chemicals used and the use of protective gear.

In the flower export business, if you are selling to large buyers such as supermarkets, they are very strict on quality, reliability of delivery and product differentiation. This is a challenge because if you do not meet these requirements, you are out of business.

Water resources is also another challenge. When it is not raining, relying on Nairobi Water Company is risky as their supply is unreliable.

#### **4.4. TANZANIA FIRM VALUE CHAIN (MOUNT MERU FLOWERS)**

Mount Meru Flowers is a small flower farm located on the slopes of Mount Meru, the second highest mountain in Tanzania after Kilimanjaro, in the northern part of the country. The farm is six kilometers from Arusha and thirty from Kilimanjaro International Airport. This is a 14.5 hectare flower farm owned by foreign investors from Sweden who put in a total capital investment of six million Euros. Its annual turnover averages US\$4.5 million and it employs 300 people.

Mount Meru Flowers produces mostly roses which it exports to the European market, Qatar, and Japan. Most of the exports to Europe are made through the Dutch auction market. They also make direct sales to supermarkets and have dealers in Italy and Switzerland to whom they sell directly. The farm sells some flowers in the local market but what they sell is the so called second grade which might not be suitable for export. The firm is foreign owned with majority shareholding from one of the Scandinavian countries. Here, we discuss the various inputs applied and the related costs. Summaries of cost figures are shown in tables 3.1 to 3.5 below. The value chain is shown in figure 3.1.

##### **4.4.1. Inputs.**

###### **a. Seedlings.**

The farm buys most of their seedlings from breeders in Kenya. They also buy some from Tanzania and in addition produce some of their own. The amortized cost of seedlings is roughly 7.5% of sales revenue. Their main suppliers both from Kenya and Tanzania are: Sunrose, Maua, Soloplant and Vegpro.

**b. Greenhouse Materials.**

These are imported mainly from France. Average amortized cost for greenhouses is 2.8% of the total revenue.

**c. Water.**

The farm gets water from a nearby river, rain and has three boreholes of its own. Irrigation equipment and pumps are imported from Israel and Italy. The total amortized cost of water supply including electricity for pumping is 2.7% of total revenue.

**d. Fertilizer.**

This is a major input and its cost has been increasing due to world oil prices. The firm gets its supply from Kenya and locally in Tanzania. The Kenya suppliers are Elgon Chemicals. Those in Tanzania are Triachem and Balton. Fertilizer costs are 6.4% of the total revenue.

**e. Chemicals**

These are required for fighting pests and weeds and are procured from Kenya and locally. The same firms that supply them with fertilizers also supply them with chemicals. Chemicals make 3.9% of total revenue.

**f. Land**

Land is expensive at roughly US\$30,000 per hectare. The tenure of ownership is a 66 year lease. The process of land acquisition is long because initially, an investor has to negotiate with the community that owns the land and then purchase it directly from them. The second step is to apply to the government for a leasehold arrangement upon which periodical lease rentals will be paid to the government.

**g. Finance**

Apart from equity, there was little external financing in the firm's capital structure. A medium term loan was obtained from Tanzania Investment Bank.

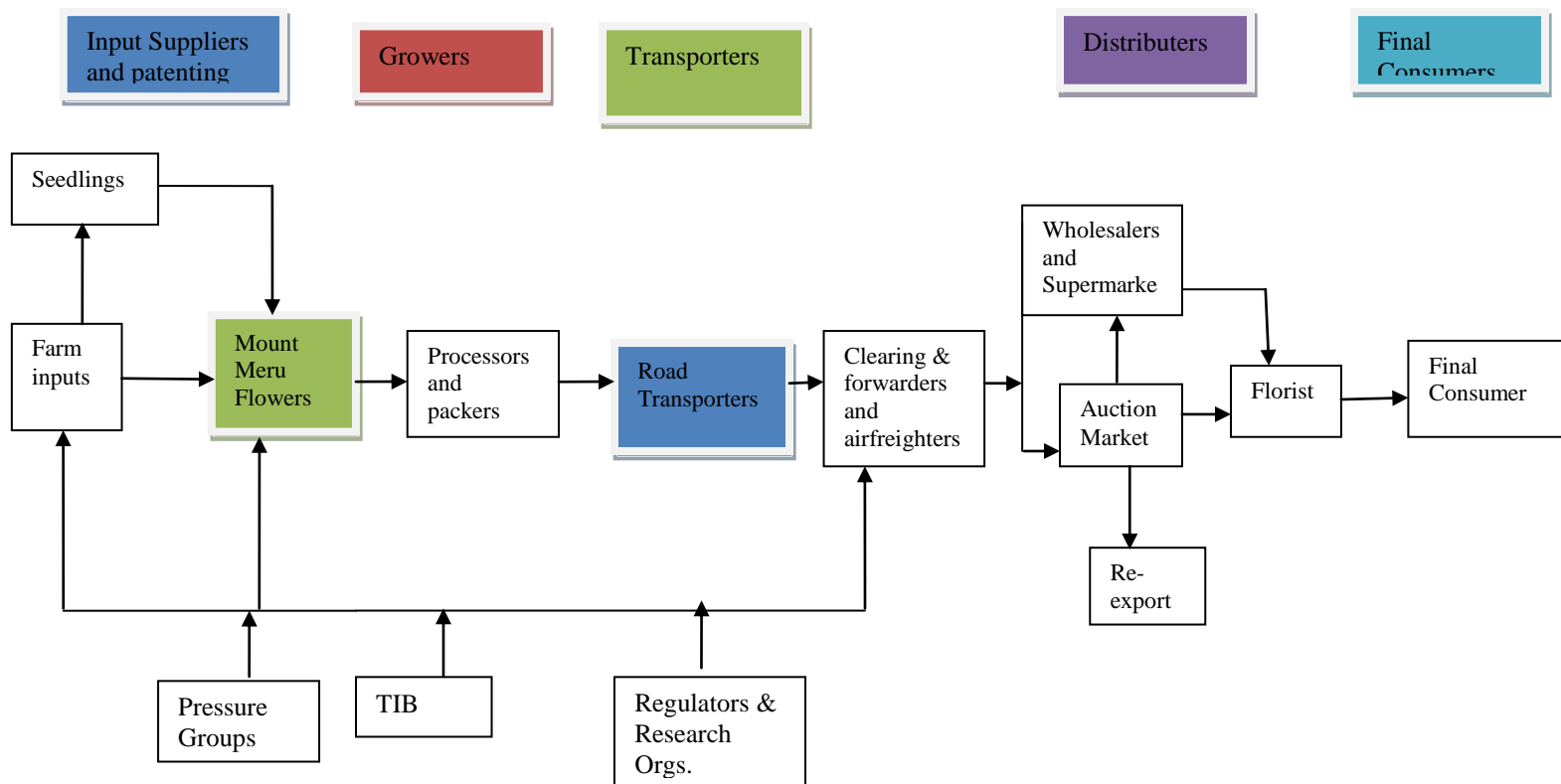
**Table 3.1: Other Inputs**

Input	Percentage
Labour	10%
Packaging	2.8%
Airfreight and clearing	34%
Auction fees	8%

**Table 3.2: Total Production Costs**

Labor	10%
Water and Energy	2.7%
Fertilizer	6.4%
Chemicals	3.9%
Trucking	6%
Greenhouse	2.8%
Seedlings	7.5%

**Fig.3.1. The Value Chain (Meru)**



**Table 3.3: Variable Sales Costs**

Packaging	2.8%
Airfreight	34%
Auction fees	8%

**Table 3.4: Simplified Gross Margin**

Production	39.3%
Packaging	2.8%
Transport and Marketing	42%
Gross Margin	16.9%

#### **4.4.2. Chain Governance.**

The governance of this chain takes a combination of modular and market. It is modular because the farm sells its flowers to supermarkets in Europe and it takes the form of market because it sells at the Dutch auction market. The modular linkage offers the farm an opportunity to receive information on customer needs. The supermarkets also put pressure on Mount Meru Flowers to improve on quality and innovate in order to adhere to stringent standards and meet customer requirements. Because of the linkage, the farm is able to maintain high levels of efficiency and quality.

The auction market offers the farm a forum for meeting and selling to customers. The auction markets offers infrastructure that would have been impossible to set up if one went alone. The market sets the prices and also is a centre for market information sharing through conferences, trade fairs and the websites.

#### **4.4.3. Opportunities Available to Mount Meru Flowers**

Mount Meru Flowers has a host of opportunities open to it. To start with, the Mount Meru area is surrounded by volcanic mountains. The soils are dark, rich and volcanic. The climate is cool and favorable for flower growing. There are also good rains and the land is enough though rather expensive.

With the good climate and soils, Mount Meru Flowers could venture into green projects such as tree planting, green energy and water conservation from which they could earn carbon credits which would improve their revenues as well as cutting their operating costs.

There are not many flower seed producers in Tanzania. Mount Meru Flowers could get into flower production for themselves and for the region.

There is abundant cheap labour. Nearby is Kilimanjaro Airport, providing an opportunity to export flowers by air to Europe. Nairobi is also less than 300 kilometers from here.

#### **4.4.4. Challenges**

Getting the right flower variety in order to maintain quality is a major challenge as the major seed producers are located in Naivasha, Kenya, which is about 400 kilometers away.

The weather is mostly cloudy, thus limiting the rate of flower growth. In addition, availability of air freight services is not adequate as few major airlines fly through Kilimanjaro airport. Mount Meru Flowers is forced to use Nairobi which is 300 kilometers away and Dar es Salaam which is 700 kilometers away by road.

Another major challenge is funding. The financial markets in Tanzania are just starting to develop. There are not many development finance institutions that could provide ample finances for flower business development. As said already, land is quite expensive and the country's laws do not allow for permanent land tenure.

#### **4.5. Comparing the Two Value Chains**

**Table 3.5: Comparisons**

Item	Percentages	
	Mount Meru	Manoa
Labor	10%	22%
Water and energy	2.7%	2.9%
Fertilizer	6.4%	3.5%
Chemicals	3.9%	3.4%
Packaging	2.8%	4.1%

**Table 3.5: Comparisons**

Item	Mount Meru Flowers	Manoa Farm
Production Costs	39.3%	45.4%
Packaging	2.8%	4.1%
Freight and Marketing	42%	24%
Gross Margin	16.9%	26.5%

Mount Meru Flowers show a lower margin than Manoa by almost 10%. The explanation for this is mainly freight costs. Manoa is close to Nairobi which has good international air connections



and the airport has many freight operators because there is a lot of business passing through there. On the other hand, Kilimanjaro and Dar es Salaam airports have low volumes and therefore per unit charges for freight are high. However, Mount Meru Flowers enjoy lower labor costs than Manoa which is close to a large city. The lower packaging costs for Mount Meru are mainly due to sourcing and type of materials used because partly the company relies on imports from Kenya.

Another contributor towards the higher margin for Manoa is due to cluster benefits. The farm is part of a larger group and is able to share costs with sister companies especially marketing and freight. Another cluster benefit is that of being able to access services offered by many supportive organizations such as chemical and fertilizer companies as well as seedling producers.

In addition, looking at comparative chain integration for the two firms, it appears that they have adopted a similar form of chain governance, which is a combination of market and modular. However, there are slight differences. Whereas it is reported that Mount Meru sells to supermarkets in three different countries in addition to the Dutch auction market, Manoa sells only to UK supermarkets apart from the auction mart. The implication is that Manoa has a closer modular integration with its buyers than Mount Meru. This benefits Manoa in terms of information sharing and quality controls.

#### **4.6. Upgrading opportunities.**

As you look at the characteristics of the two value chains, you see a number of opportunities for upgrading. One area that is obvious is seed production and variety improvement. The firms are spending a lot of money in buying seedlings and paying annual royalties for them. They should invest in research and innovations to search for better varieties of their own. There is need to search for varieties that have long shelf lives, straighter stems, larger heads and sweeter smells. This calls for research.

They could also invest in innovations meant to reduce reliance on imported expensive inputs. Examples are local alternatives for greenhouse equipments, chemicals, fertilizers and packaging materials. Is it necessary to import heavy greenhouse materials all the way from Israel where cost of production is high? Why not look for even wooden alternatives? Organic farming would also be a good area to search for alternatives.

The firms must embrace ICT which will help expand their horizons in reaching distance markets. Instead of relying on traditional European markets, ICT will facilitate tapping markets in other continents without necessarily having to travel there.

Another area where there is need to search for opportunities is alternative product areas in flowers. Could perfumes be produced out of flowers? Is it possible to produce certain varieties of herbal teas from flowers? Flower farmers can also participate effectively in carbon trading by embracing green methods in flower production as well as tree planting.

## 5.0. DISCUSSION AND CONCLUSIONS

From the above value chain analyses it has been possible to obtain useful indicators that will enable us to tell on the competitiveness of the flower sector in Kenya. We are also able to compare with Tanzania using Mount Meru Flowers value chain. A value chain approach is useful in telling us about the competitiveness of a sector because of its effectiveness in explaining the distribution of tasks, risks, responsibilities and margins along the market chain (Riedel, B, et al-2009). The value chain developed for the flower farm in Kenya illustrates in many ways the areas of strength for the Kenya flower sector as well as the areas of weakness.

The results of the analysis show us where the sector is strong. For example, Nairobi is a communication hub for Africa and offers easy access to international flight connections with ample cargo capacity. This is why the cost of freighting and marketing at 24% of sales compares favorably with the Tanzania value chain which registered 42% on sales. There are four international airports in Kenya located in close proximity to flower growing centers through which the flowers are exported to the markets abroad. Related to this, there is availability of cooling and storage facilities for flowers and vegetables as well as freight handlers who are specialized in flowers.

Another positive aspect of the flower sector in Kenya is that the flower industry is self regulated and private sector controlled though the government has created institutions that provide research and inspection services to support the sector. Sector association like the Kenya Flower Council (KFC) and the Flower Producers and Exporters Association of Kenya regulate the sector in order to ensure quality products for the markets. The associations have developed and try to enforce strict codes and standards and provide certifications required to meet the strict flower market demands. This has made it possible to maintain crucial linkages with buyers in Europe who, apart from assuring a steady demand for the product, provide useful information and updates from the market about customer requirements. This is a very important contributor towards the competitiveness of the sector in in the global market place.

Another contributor to the competitiveness of the Kenya flower sector is the development of a cluster of support organizations. There are many seed producers as well as suppliers of chemicals, fertilizers, greenhouse materials and packaging materials. The financial markets are equally developed to provide the required financing for business. This makes it comparatively cheaper to produce flowers and be able to compete globally.

Chain linkages with buyers abroad make the flower farming in the two countries competitive. But it was observed that Manoa has more focused linkages with buyers in only one country, UK, as opposed to Mount Meru that sells to buyers in three different countries in Europe. This gives Manoa a competitive advantage.

In terms of infrastructural development, Kenya compares favorably in terms of reliability of power supply and the road network. However, in terms of cost, Kenya registered a higher rate of 2.9% compared with Tanzania's 2.7% for water and energy.

Cost of labor in Kenya is also higher at 22% compared to Tanzania where it is 10%. This can be attributable to Manoa being close to a larger metropolitan city compared to Arusha.

Overall we should be able to conclude that the flower sector in Kenya is more competitive than that of Tanzania. In addition to the factors cited above, the overall gross margin of the Kenyan firm is higher at 26.5% compared to that of the Tanzanian firm at 16.9%.

In conclusion, the value chain analyses reveal a number of upgrading opportunities which should make the flower business in the two countries more competitive. It is possible to innovate and reduce costs, come up with new varieties and even new products. ICT innovation is an area that has not been exploited and it could help the farmers reach markets across the globe.

## References

1. Alan, M.E. A. A, *Crowding-out and Crowding-in Effects of Government Bonds Market on Private Sector Investment (Japanese Case Study)*, Institute of Development Economics, Discussion Paper no. 74, 2006.
2. Anderson, G. (2000), *The Hidden MSE Services Sector: Research into Commercial BDS Provision to Micro and Small Enterprises in Vietnam and Thailand*. SEED Working Paper no.5, International Labor Office, Geneva.
3. Atukeren, E, *Economic and Institutional Determinants of the Crowding-in Effects of Public Investments in Developing Countries*, Swiss Institute for Business Cycle Research (KOF/ETH) WEH-ETH Zentrum, CH- 8092 Zurich, 2005.
4. Fromm, I. and Juan A. Dubón, *Upgrading and the Value Chain Analysis: The Case of Small-scale Coffee Farmers in Honduras*, Tropentag 2006 University of Bonn, October 11-13, 2006, Conference on International Agricultural Research for Development
5. Gereffi, G, J. Humphrey and T. Sturgeon, *The governance of Global Value Chains*, Review of International Political Economy, 12:1, February 2005: 78-104.
6. Gereffi, G. (1999) International trade and industrial upgrading in the apparel commodity chain. Journal of International Economics, 48: 37-70.
7. Humphrey, J (2005), *Shaping Value Chains for Development: Global Value Chains in Agribusiness*, Paper written for GTZ, Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ) GmbH, [www.gtz.de](http://www.gtz.de)

8. Humphrey, J. and Schmitz, H. (2004) Chain governance and upgrading: taking stock. In H. Schmitz (ed.), *Local Enterprises in the Global Economy: Issues of Governance and Upgrading*. Cheltenham: Elgar, pp. 349-381
9. Kaplinsky, R and Mike Morris, *A Handbook for Value Chain Research*, Prepared for IDRC, 2000
10. Kaplinsky, R and Mike Morris, *Value chain analysis: a tool for enhancing export supply policies*, International Journal of Technological Learning, Innovation and Development, Vol.1, No.3, 2008.
11. Memedovic, Olga, *Agri-Food Value Chains and Poverty Reduction: Overview of Main Issues, Trends and Experiences*, Research and Statistics Branch, UNIDO, 2008.
12. Nadvi, K. and Thoburn, J. (2004) *Vietnam in the global garment and textile value chain: impacts of firms and workers*. Journal of International Development, vol. 16, No. 1: 111-12
13. Papademetriou P (1998). Cut flower production in Asia. Introductory remarks. Food and Agriculture Organisation of the United Nations Regional Office for Asia and the Pacific Bangkok, Thailand. RAP Publication 1998/14.
14. Riedel, B, W. Bokelmann, M.Canavari (2009), *Combining Cluster and Value Chain Approaches to Analyse the Competitiveness of Fresh Vegetable Producers: Case Studies in Germany, Italy and Spain*. Paper Presented at the 113<sup>th</sup> EAAE seminar, "A resilient European food industry and food chain in a challenging world", Chania, Crete, Greece, 3-6 September 2009.
15. Ruben, R, T. Van Boekel, A. van Tilburg and Jacques Trienekens, *Governance Regimes for Quality Management of tropical Food Chains*; Wageningen, 2006
16. Schmitz, H. and P. Knorringa (2000) *Learning from global buyers*. Journal of Development Studies 37(2): 177-205
17. Schmitz, H, *Value Chain Analysis for Policy Makers and Practitioners*, Institute of Development Studies, University of Sussex, England (ILO, 2005).
18. UNDP, Government of the Netherlands, ILO, UNIDO (1988), *Development of Rural Small Enterprises: Lessons from Experience*, Vienna, UNIDO.
19. World Bank (2005), *Kenya Growth and Competitiveness*, Report No.31387-KE, January 27, 2005
20. World Bank (2007), *Moving Towards Competitiveness: A Value Chain Approach*, The Foreign Investment Advisory Service, The World Bank.

## **Developing and Testing Supply Chain Environmental Performance Measures**

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### **Introduction and Research Background**

Issues of global warming and climate change are a worldwide concern (IPCC, 2007). Supply chain and energy security are the two out of four major emerging issues that will fundamentally shape our future and are central to the functioning of the world economy and well-being of the global society (World Economic Forum, 2008). In the field of business and management, there is an onus on organizations to minimise the impacts on the natural environment (Walker et al., 2008; Hart, 1995; Henriques and Sadorsky, 1999).

Anthropogenic carbon dioxide (CO<sub>2</sub>) is the most significant of the six greenhouse gases and is the main contributor to global warming. The majority of the UK's CO<sub>2</sub> emissions are generated from three key sectors; energy supply (40%), road transport (22%) and business (16%) (Defra, 2009). Carbon dioxide emissions from transport are rising faster than any other sector and are likely to become the largest source of UK emissions in the near future (Carter and Ockwell, 2007). Organizations are therefore under increased pressure and scrutiny from customers and governments on their compliance with environmental and social responsibility (Wolf and Seuring, 2010).

The UK has a number of goals to improve its environmental performance, both internationally and domestically, including reducing greenhouse gas emissions. The UK government originally signed the Kyoto protocol to reduce greenhouse gas emissions by 12.5% below base year level over the period 2008-2012 but subsequently set an aggressive domestic goal of reducing carbon dioxide (CO<sub>2</sub>) emissions by 80% below base levels by 2050 (Defra, 2007, 2009).

With 75% of an organization's carbon footprint attributable to logistics and transport activity (IOMA, 2008) and the total UK transport sector contributing to one third of UK carbon emissions (Transport and Climate Change, 2007), it is no surprise that non-energy companies are beginning to assess the energy consumption and emissions in their supply chains as a way to reduce their carbon emissions. Logistics and supply chain managers are thus faced with the challenge of how to incorporate environmental management practices into their daily decision making processes. Understanding the tradeoffs between optimal supply chain efficiency, e.g. lean, green and/or global, and the impact on the natural environment is part of that challenge.

However by viewing these strategic initiatives together and having a 'toolkit' of measures to manage supply chain environmental performance, logistics and supply chain managers will have a better insight into their synergies and tradeoffs (Mollenkof et al., 2009). Managing and reporting environmental performance can also lead to significant cost savings and productivity gains (Klassen and McLaughlin, 1996). And yet, there has been little work done in developing, testing and incorporating environmental measures into the existing bank of supply chain performance measures (Shaw et al., 2010). This paper reports on a study in-progress attempting to develop, test and validate green supply chain performance measures and also investigate if there are any higher-level, parsimonious constructs that result from such measures.

### **Performance Measurement (PM)**

Performance measures are essential for managing and navigating organizations through turbulent and competitive global markets. They allow organizations to track progress against their strategy, identify areas of improvement and they act as a good benchmark against competitors or industry leaders. The information provided by performance measures allows managers to make the right decisions at the right times (Gunasekaran et al., 2004).

A performance measure can be defined as a set of metrics or measures used to quantify the efficiency and/or effectiveness of an action (Neely et al, 1995). It is a verifiable measure, which can be expressed in either quantitative or qualitative terms with respect to a reference point. Performance measures are important in translating an organisation's mission or strategy into reality. Their role is to communicate, control and improve (Melnik et al., 2004) and to analyse both the effectiveness and efficiency in accomplishing a given task (Mentzer and Konrad, 1991). Performance measures are multi dimensional and their various taxonomies provide a degree of complexity to practitioners.

A significant amount of literature has been published on the subject of performance measurement. Between 1994 and 1996, some 3615 articles were published on performance measurement (Neely, 1999). In 1996, one new book appeared every five hours in every working day. Neely (1999) described this as a 'performance measurement revolution'.

### **Supply Chain Performance Measurement (SCPM)**

Supply chain performance measurement has emerged as one of the major business areas where companies can obtain a competitive advantage (Lee, 2002). It is a key strategic factor for increasing organisational effectiveness and for better realisation of organisational goals such as enhanced competitiveness, better customer care and profitability (Gunasekaran et al., 2001). A key feature in the business environment is that supply chains, not companies, compete with one another (Christopher, 2005).

Traditionally, logistics and supply chain performance measures have been retrospective, quantitative and orientated around measuring cost, time and accuracy. Knowing how an organisation has performed in the past will not necessarily indicate how it will perform in the future. One of the most prevalent issues associated with performance measurement is having too many metrics. Some organizations are using hundreds which are often not aligned to the organisation's strategy (Hoffman, 2006). This leads to confusion, often results in 'paralysis by analysis' and presents difficulties in conducting benchmarking exercises. There is a requirement to move from 'performance proliferation' to 'performance simplification' (Morgan, 2007).

To address this confusion, Caplice and Sheffi (1995) recommended that managers should continually review and evaluate their supply chain performance metrics in order to make sense of the growing number of supply chain metrics and to ensure the metrics reflect the ever-evolving supply chain and business environment. They provided eight criteria on which to judge the quality of metrics: validity, robustness, usefulness, integration, compatibility, economy, level of detail and behavioural soundness. These eight criteria could be used to help develop environmental performance metrics for supply chains.

Performance measurements evolve as new challenges are met. The natural environment is probably one of the biggest challenges facing the evolution of performance measurement today (Morgan, 2007).

### **Green Supply Chain Performance Measurement (GSCPM)**

As a consequence of this challenge, the cross-disciplinary field of green supply chain management (GSCM) has grown in interest amongst supply chain researchers and practitioners. This is primarily because of climate change issues, diminishing raw materials, excess waste production, increasing levels of pollution and because it is a good source of competitive advantage. There have been a large number of special issues devoted to GSCM, which have concentrated on specific nodes or activities within the supply chain (e.g. green purchasing or reverse logistics). The fragmentation, compartmentalization and complexity of this research support the fact that this is fertile ground and a growing area of research (Sarkis et al., 2011). There is a requirement to pull together the contribution in order to move the discipline forward and provide guidance to academics and practitioners.

Furthermore, the scope of 'green' or 'environmental' is considerable. It can relate to issues such as ecological concerns, conservation (planet and animal), corporate social responsibility (CSR), humanitarian concerns, fair trade, clean water, animal welfare, equality, and sustainability. This variety presents a number of challenges to academics and practitioners as the broad and complex definition can imply different things to different people (Saha and Darton, 2005).

However, environmental or 'green' supply chain performance measurement (GPSCM) as a discipline and practice is virtually non-existent (Hervani et al., 2005). And yet, there is a

proven link between environmental management practices and financial performance and competitiveness, with obvious win-win opportunities (Klassen and McLaughlin, 1996; Rao and Holt, 2005). So why are firms not adopting and measuring their environmental performance? A major barrier to the adoption of green supply chain performance measurement is economic reasons; organizations are put off by the large investment required upfront resulting in low adoption rates (Zhu and Sarkis, 2004). Organizations are also confused over what to measure, how to measure and who should measure.

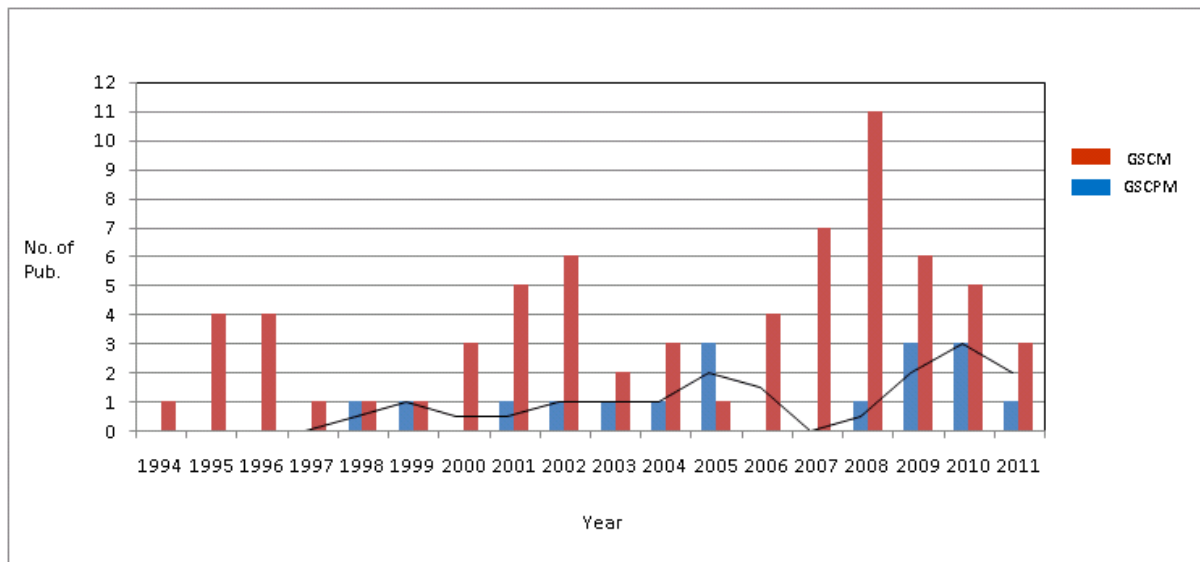
Those organizations which are closer to the consumer market deem environmental supply chain practices as more important than small to medium sized organizations which do not have the resources or investment to implement such practices (Nawrocka, 2008). The challenge is convincing organizations that this is a worthwhile investment. Therefore, more research and evidence is required if organizations are to fully adopt and embrace green management practices and green performance measurement.

The purpose of measuring green performance in supply chains is two-fold; there is a requirement for external reporting, e.g. public disclosure programs like the global reporting initiative (GRI) or the carbon disclosure project (CDP), and firms can use such measures for benchmarking their performance against competitors. There is also a requirement for internal analysis, to help improve internal processes and to manage such things as pollution control which help to protect the natural environment. There are other specific pressures/motivators of green performance measurement in supply chains, including external pressures from customers, competitors and government legislation and internal pressures from stakeholders and suppliers (Holt and Ghobadian, 2009).

Despite these pressures and motivations there is a lack of published empirical research in environmental or green supply chain performance measurement within the field of logistics. Our literature review identified 68 articles devoted to green supply chain management (GSCM) published between 1994 and 2011. In contrast, only seventeen articles have been published in the last 17 years on green supply chain performance measurement (GSCPM). Half of these publications are published outside the field of logistics (Figure 1). Furthermore, of the 17 articles thus far on GSCPM, only seven have are empirical studies while the remaining ten are literature reviews/general reviews.

**Figure 1: Green Supply Chain Management (GSCM) and Green Supply Chain Performance Measurement (GSCPM). Publications by year**



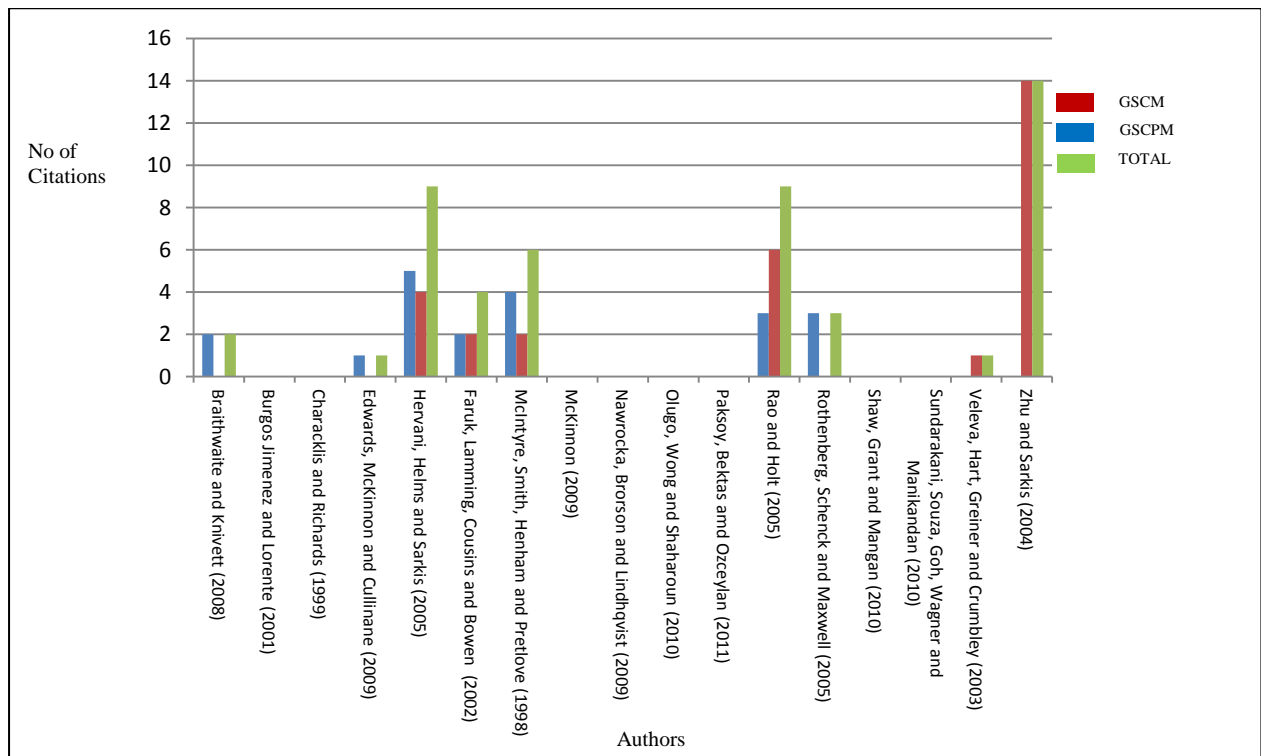


This trend suggests that GSCPM has not been fully explored and embraced within the supply chain and logistics discipline but is evolving and developing from within other environmental related disciplines such as: *industrial ecology*, *cleaner technology*, *waste recycling*, *resource management and benchmarking* disciplines. Seventeen articles published in the last 17 years is not a significant contribution and suggests that research is still at an exploratory stage and reinforces the requirement for more empirical tests.

Figure 1 also shows a trend in the journal publications by year, with GSCM rising steadily in the late 1990's as the subject gained momentum, declining slightly in the early 2000's, rising sharply again in 2008 and then declining in 2009-11. This trend and interest could be linked to the world recession, which has had a huge impact on the focus logistics managers. This rise and fall in both research areas may have been influenced by economic cycles with a decline in environmental focus during times of recession when cost takes over as a primary objective for organizations (Spens and Kovacs, 2010). Figure 1 also suggests that both research areas are growing and developing, however GSCM is developing at a faster and more prominent pace than the GSCPM.

The most frequently cited work within the 17 key articles is Zhu and Sarkis (2004) with 14 citations (Figure 2). Their article reviews the relationship between operational practices and performance amongst early adopters of GSCM practices in the Chinese manufacturing sector. They identify a positive relationship between GSCM practices and economic performance, with 'win win' opportunities.

**Figure 2: Citation analysis of Green Supply Chain Management (GSCM) and Green Supply Chain Performance Measurement (GSCPM) articles (1994 to 2011)**



The most frequently cited GPSCM article with five is Hervani et al. (2005). They provide an integrative framework for the design and evaluation of GSCPM which is of significant relevance to this study as they design a framework from within which environmental performance measures for supply chains can be selected and evaluated.

### Research Objectives

This paper and presentation addresses these gaps found in the literature and discusses findings to date of a current research study into developing, testing and validating green supply chain performance measures. Five questions were proposed for this study:

1. What GSCPM is being used?
2. Which GSCPMs are important (usefulness and impact?)
3. Can GSCPM be integrated within existing supply chain performance frameworks?
4. What are the drivers and barriers for GSCPM?
5. Do any emerging variables and constructs mirror those found in extant literature on GSCPM?

### Methodology

The above questions represent a fairly new area of research and theory development, and thus this study is using theoretical and methodological triangulation to maximize the amount of data collected and to explore the research phenomena from different perspectives (Mangan et al., 2004).

A literature review (Shaw et al., 2010) was conducted in two phases. First, the contents of the five leading logistics journals (Menachof et al., 2009) were examined for articles relating to the following five word search: performance management (PM), supply chain management (SCM), green supply chain management (GSCM), environmental SCM (ESCM) and environmental management (EM). The key words were selected by constructing a relevance tree which was used to identify other related areas of the literature which required exploring.

Second, a key word search was performed on ISI Web of Science database to specifically identify a list of key authors, journals and research outside the field of logistics relating to environmental performance management. The bibliographies and reference lists from key journals were used to trace new journals relevant to the research area.

Based on this literature review the empirical study being conducted in 2012 is comprised of three phases. The first phase is inductive and involves conducting focus groups with leading supply chain managers and/or directors to explore the five research questions, identify current and/or required practices employed in industry, and generate a battery of variables and constructs for further testing. The focus group sessions created a forum in which stimulated new ideas, discussion and constructs on the development and selection of GSCPM. The second phase is deductive and consists of an online survey of UK logistics professionals to statistically test and validate the variables and constructs emerging from the focus groups and literature review. The third phase is again inductive and consists of conducting in-depth interviews with leading supply chain managers and/or directors to verify the survey findings.

Phase 1 of the research design included conducting two focus groups sessions of two hours each with approximately ten respondents in January 2012. The focus group respondents comprised a random sample of leading supply chain practitioners and professionals which were members of the Chartered Institute of Logistics and Transport (UK). The focus groups were professionally moderated and the respondents were asked a series of questions which linked directly back to the five primary research questions. The focus groups were audio recorded to enable a full transcription of the respondent's dialogue. Once transcribed the detailed dialogue was coded into themes using the data reduction, data display and conclusion drawing/verification technique described by Miles and Huberman (1994). Table 1 details the key measures and themes which were identified within the focus group research.

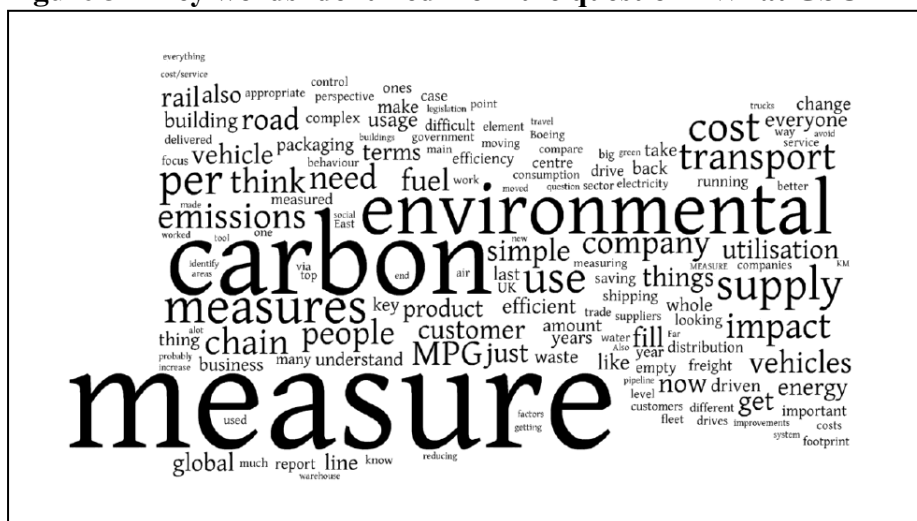
**Table 1 – Focus Group Key Measures and Themes**

<b>Research Questions</b>	<b>Key Measures, Themes &amp; Constructs</b>
<b>What GSCPM are being used?</b>	No measures specifically for supply chain Energy consumption Energy efficiency Utilisation Employee behaviour and social norms Packaging consumption Waste Recycling Fuel efficiency and consumption Emissions (air, sea and land) Cost/Financial Legislation Carbon management Relationship of cost to environmental Relationship of MPG to vehicle fill Relationship of Cost/Service/Carbon Utilities (Electricity, gas and water)
<b>Which GSCPM are important (usefulness and impact?)</b>	Carbon Emissions Energy Efficiency All emissions Fuel Efficiency Waste reduction Packaging optimisation Retailer driven measures All resource used along the supply chain Those which are simple and not complex Clear, visible, transparent and consistent Easy to calculate Specific and not too generic Environmental impact per supply chain activity

	Environment, social and economic (TBL) Vehicle fill and utilisation End to end supply chain (scope) Cost Service Carbon Employee behaviour and social norms Gaps, we do not measure everything!
<b>Can GSCPM be integrated within existing supply chain performance frameworks?</b>	Yes, a win-win situation (cost and green – there is a link, one drives the other) TBL benefits Resource efficiency Company survival/sustainability Decision making BSC, Dow Jones Sustainability Index, SCOR, CRC, GRI and Carbon Trust
<b>What are the drivers and barriers to measuring GSCPM?</b>	<u><b>Drivers</b></u> Cost and bottom line Legislation Green agenda Suppliers/Retailers The brand Directors/CEOs Customer Private sector versus public (bottom line versus budget) <u><b>Barriers</b></u> Complexity/ Difficulty in measuring Cost, time, people Who measures? What is to be measured? Collaboration/Trust Scope (where do you start and stop) Lack of visibility and control No major barriers Transport infrastructure No drivers – no one is asking

To further validate the focus group data, a key word search and the *wordle* tool technique were used to identify and display the key words and themes which emerged from each question within the two focus group transcripts (Figure 3). The data display technique was useful in helping to organize, compress and draw conclusions from the focus groups (Miles and Huberman, 1994).

**Figure 3 – Key words identified from the question “What GSCPM is being used?”**



The focus group research identified a total of 27 GSCPM measures (Table 2). The measures fell into discrete categories, such as transport, warehouse, emissions, utilisation and people.

**Table 2 – GSCPM Identified from the Focus Group Research**

<b>GSCPM Identified</b>
1. Electricity consumption measures (utilities)
2. Driver behaviour (e.g. telematics)
3. Carbon emissions of an activity
4. Overall company carbon footprint measures
5. Vehicle mileage measures
6. Packaging consumption measures
7. Fuel consumption measures (e.g. MPG)
8. No of pallet movements or touches per customer delivery
9. Warehouse utilisation measures (e.g. pallet occupancy)
10. Fuel consumed per case or item delivered to the customer
11. Vehicle running costs
12. Waste recycling measures
13. Warehouse efficiency measures
14. Water consumption measure (utilities)
15. Carbon emissions measures
16. Gas consumptions measures (utilities)
17. Overall supply chain carbon footprint measures
18. Vehicle fill/utilisation measures (e.g. empty running)
19. Energy used per case or item delivered to the customer
20. Green house gas emissions (nitrous oxide, methane etc)
21. Cost measures (e.g. cost of running your warehouse, fleet etc)
22. Employee training (environmental training)
23. No of container unit movements (TEU)
24. Employee travel
25. Resource efficiency (raw materials, asset utilization)
26. Shipping pollutant (ballast pollution)
27. Carbon emissions per x or case delivered to the customer

As a consequence, the following key constructs were identified during the focus group research:

- Transportation
- Utilisation/usage/fill
- Cost/Financial
- People/employees
- Carbon
- Emissions
- Energy
- Complexity/difficulty

These key constructs mirror most of the extant constructs found in the background literature. The only new constructs identified were utilisation/usage/fill and energy in the form of utilities (water, gas and electricity).

The focus group research identified a great deal of confusion and frustration amongst practitioners on what to measure and why. In some organizations GSCPM is not being measured at all. This lack of measurement is because no one appears to be driving the agenda apart from the retailers and large customers. The practitioners felt there were too many disparate bodies and legislation, nothing really matched up with no measurement commonality. There was a strong desire by both groups of respondents to come up with a set

of simple, robust, easy to calculate and easy to understand GSCPM for the entire supply chain.

Laing et al (2006) suggested that for effective green supply chain management to take place, it is necessary to evaluate the overall performance of the entire supply chain. This was also the consensus of the focus groups, however in reality, the practitioners found it difficult to know where to start and stop measuring and who should be measuring in their supply chain. They lacked the sophisticated tools to measure GSCPM. They also stated they were not in full control of their entire supply chain and therefore could only measure what was within their control.

The practitioners also commented on how performance measures had changed over the last 30 years. Historically, measures were more cost/service focused (e.g. 99% on time in full and error free) and now they were becoming more environmentally focused. This is similar to the evolutionary trend identified by Morgan (2007). There was a strong consensus in both focus groups, that in the absence of any direction, the practitioners would continue to measure those things that really mattered to their customers or those which brought a financial return. Cost and financial return was a dominant construct to measuring GSCPM.

There was a call from both groups for clear government guidelines on what to measure, standardisation, transparency and simplicity. The respondents also requested that a value or cost be placed on measuring GSCPM (the cost of being green) for example: the value of carbon. GSCPM had to stack up financially to work successfully and be accepted. This would enable practitioners to easily calculate and incorporate the cost of being green into their standard financial reporting. This 'greening cost' concept was also identified by Olugo et al. (2010) in their development of key performance measures for the automobile green supply chain.

The respondents were unaware of what environmental managements systems (EMS) their organisation's had in place, e.g. ISO 14001. This suggested that EMS were not a key part of their responsibility and could be a potential barrier to the development of GSCPM. This divergent mindset of traditional supply chain performance measurement and environmental management was also identified by McIntyre and Smith, (1998).

The Balanced Scorecard, own in house company reporting (particularly in large organizations), the Global Reporting Initiative, six sigma and supply chain reference model (SCOR) were all identified as reporting tools which organizations used to measure their supply chain performance and could potentially be used to measure and integrate GSCPM. The respondents believed this integration would ultimately help practitioners to make decisions which would help the company to survive, be more sustainable and be more resource efficient.

A key construct in the focus groups were people and their social norms. As a society there is a social norm that resources are finite without consideration for future generations. The practitioners urged each other to be given the knowledge and information on environmental issues to enable them to be translated into a concerted action before it was too late e.g. measuring GSCPM. From a 'triple bottom line' point of view, they stressed there has to be a link made between financial, environmental and social criteria. For example: pollution causes acid rain which in turn destroys agricultural crop yields and this has an impact on society as a whole. This finding supports the concept of SCM sustainability introduced by

Carter and Rogers (2008) as the integration of environmental, social and economic criteria in a SCM context. The integration of these criteria enables an organisation to fulfil long term economic viability. This concept is an important consideration for the development of GSCPM.

The next step of the research process (phase 2) will be to statistically test and validate the 27 GSCPM and constructs in an online survey with UK logistics professionals.

### **Expected Outcomes/Contributions**

It is anticipated that this study will contribute to knowledge and practice by providing a consistent, thorough and validated set of supply chain environmental performance measures that will give organizations insight on how to measure and mitigate their impact on the environment and which can be used as a source of competitive advantage. The study will also raise awareness among academics and practitioners of the importance of environmental impact mitigation and adaptation (Abukhader and Jönson, 2004), and will help pull together and make sense of the complexity and fragmentation which exists in the current research. Additionally it will contribute to methodology by following a call for qualitative research (Näslund, 2002; Mangan et al., 2004; Aastrup and Halldórsson, 2008). It is further anticipated that the research will provide new insights into the development and testing of environmental/green supply chain performance measures for supply chains.

### **References**

- Aastrup, J. and Halldórsson, Á. (2008), "Epistemological Role of Case Studies in Logistics - A Critical Realist Perspective," *Nofoma 2008*, at Helsinki (Finland).
- Abukhader, S. and Jönson, G. (2004), "Logistics and the environment: Is it an established subject?" *International Journal of Logistics: Research & Applications*, Vol. 7, No. 2: pp 137-149.
- Caplice, C. and Sheffi, Y. (1994), "A Review and Evaluation of Logistics Metrics", *International Journal of Logistics Management*, Vol.5, No. 2, pp 11-28.
- Carter, N. and Ockwell, D. (2007) "New Labour, New Environment? An Analysis of the Labour Government's Policy on Climate Change and Biodiversity Loss", Report Commissioned by Friends of the Earth.  
<http://celp.org.uk/webpages/projects/foe/fullreportfinal.pdf> [accessed 26.05.12].
- Carter, C.R. and Rogers, D.S. (2008), "A framework of sustainable supply chain management: moving toward new theory" *International Journal of Physical Distribution and Logistics Management*, Vol. 38, No, 5, pp. 360-387.
- Christopher, M. (2005), *Logistics and Supply Chain Management – Creating Value-Adding Networks*. Third edition. Prentice Hall. Financial Times.
- Defra (2007), *Environment & Climate Change*, [www.defra.gov.uk](http://www.defra.gov.uk), [accessed 26.05.08].

- Defra (2009), *UK Climate Change Sustainable Development Indicator: Greenhouse Gas Emissions*, [www.defra.gov.uk](http://www.defra.gov.uk), [accessed 04/04/09].
- Gunasekaran, A., Patel, C. and Tirtiroglu, E. (2001), "Performance measures and metrics in a supply chain environment", *International Journal of Operations & Production Management*, Vol. 21 Issue: 1/2, pp.71 – 87.
- Gunasekaran, A., Patel, C. and Tirtiroglu, E. (2004), "Framework for supply chain performance measurement", *International Journal of Production Economics*, 2004, 87, 3, pp. 333.
- Hart, S.L. (1995), "A natural-resource-based view of the firm", *Academy of Management Review*, Vol. 20, No.4, pp. 986-1014.
- Henriques, I. and Sadorsky, P. (1999), "The Relationship between Environmental Commitment and Managerial Perceptions of Stakeholder Importance", *Academy of Management Journal*, Vol. 42, No. 1, pp. 87-99.
- Hervani, A.M., Helms, M. and Sarkis, J. (2005), Performance Measurement for Green Supply Chain Management, *Benchmarking: An International Journal*, Vol. 12, No. 4 pp. 330-353.
- Hoffman, D. (2006), "Getting to World-Class Supply Chain Measurement," *Supply Chain Management Review*, Vol.10, No.7, pp. 18-24.
- Holt, D. and Ghobadian, A. (2009), "An empirical study of green supply chain management practices amongst UK manufacturers", *Journal of Manufacturing Technology Management*, Vol. 20, No.7, pp. 933 – 956.
- IOMA (2008), *Export News – Companies Realize Green Logistics Can Save Money*, [www.ioma.com/global](http://www.ioma.com/global), [accessed 26.05.08].
- IPCC (2007), *Climate Change 2007: The Physical Science Basis*, Working Group 1 Contribution to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (UNEP), Cambridge: Cambridge University Press.
- Klassen, R.D. and McLaughlin, C.P. (1996), "The impact of environmental management on firm performance," *Management Science*, Vol. 42, No. 8, pp. 1199-1214.
- Laing, L., Feng, F. and Cook W.D. (2006), "DEA models for supply chain efficiency evaluation chain" *Annals of Operations Research*, Vol.145, pp. 35-49.
- Lee, H. (2002), "Aligning supply chain strategies with product uncertainties", *California Management Review*, Vol. 44, No, 3, pp. 105-19.
- Mangan, J., Lalwani, C. and Gardner, B. (2004), "Combining quantitative and qualitative methodologies in logistics research," *International Journal of Physical Distribution & Logistics Management*, Vol.34, No. 7: pp. 565-578.
- McIntyre, K. and Smith H.A. (1998), "Logistics Performance Measurement and Greening Supply Chains: Divergent Mindsets" *International Journal of Logistics Management*, Vol. 9, No, 1 pp. 57-67.
- Melnyk, S.A., Stewart, D.M. and Swink, M. (2004), "Metrics and performance measurement in operations management: dealing with the metrics maze." *Journal of Operations Management*, Vol. 22, No.3, pp. 209-217.



- Menachof, D., Gibson, B., Hanna, J. and Whiteing, A. (2009), "An analysis of the value of supply chain management periodicals", *International Journal of Physical Distribution & Logistics Management*, Vol. 39, No.2, pp. 145 -166.
- Mentzer, J.T. and Konrad, B.P. (1991), "An Efficiency/Effectiveness Approach To Logistics Performance Analysis" *Journal of Business Logistics*, Vol. 12, No. 1, pp. 33-62.
- Miles, M.B. and Huberman, A.M. (1994), *Qualitative Data Analysis*, An Expanded Source book, Second Edition, Sage Publications.
- Mollenkopf, D., Stolze, H., Tate, W.L and Ueltschy, M. (2009), "Green, lean, and global supply chains." *International Journal of Physical Distribution & Logistics Management*, Vol. 40, No.1/2: pp. 14-41.
- Morgan, C. (2007), "Supply network performance measurement: future challenges?" *The International Journal of Logistics Management*, Vol.18 No.2, pp. 255-273.
- Nawrocka, D. (2008), "Inter-organizational use of EMSs in supply chain management: some experiences from Poland and Sweden", *Corporate Social Responsibility and Environmental Management*, Vol. 15 No. 5, pp. 260-9.
- Näslund, D. (2002), "Logistics needs qualitative research – especially action research." *International Journal of Physical Distribution & Logistics Management*, Vol. 32, No.5: pp. 321-338.
- Neely, A.D., Gregory, M. and Platts, K. (1995), "Performance measurement system design: A literature review and research agenda" *International Journal of Operations & Production Management*, Vol. 15, No. 4, pp. 80-116.
- Neely, A.D. (1999), "The Performance Measurement Revolution: Why Now and What Next?" *International Journal of Operations and Production Management*, Vol. 19, Issue 2, pp. 205-228.
- Olugo, E.U., Wong, K.Y. and Shaharoun, A.M. (2010), "Development of key performance measures for the automobile green supply chain", *Resources, Conservation and Recycling*, Vol. 55, No.6, pp. 567-579.
- Rao, P. and Holt, D. (2005), "Do green supply chains lead to competitiveness and economic performance?", *International Journal of Operations & Production Management*, Vol. 25, No. 9, pp.898 – 916.
- Saha, M. and Darnton, G. (2005), "Green Companies or Green Con-panies, Are Companies Really Green, or Are They Pretending to Be?" *Business and Society Review*, pp. Vol. 110, pp. 117-157.
- Sarkis, J., Zhu, Q. and Lai, K. (2011), "An organizational theoretic review of green supply chain management literature." *International Journal of Production Economics*, Vol. 130, pp. 1-15.
- Shaw, S., Grant, D.B. and Mangan, J. (2010), "Developing environmental supply chain performance measures," *Benchmarking: An International Journal*, Vol. 17, No. 3: pp.320-339.
- Spens, K and Kovacs, G. (2010), "Back to Basics - Is Logistics about cutting cost?", *International Conference on Industrial Logistics, Logistics and Sustainability Conference Proceedings*, IME - Military Institute of Engineering, Rio de Janeiro – Brazil, pp. 281-288.

- Transport and Climate Change (2007), *A New Deal for Transport: Better for Everyone* – [online] Available from <http://cfit.independent.gov.uk/> [accessed 10/01/10].
- Walker, H., di Sisto, L. and McBain, D. (2008), “Drivers and barrier to environmental supply chain management practices: lessons from the public and private sectors”, *Journal of Purchasing & Supply Management*, Vol. 14, pp. 69-85.
- Wolf, C. and Seuring, S. (2010), “Environmental impacts as buying criteria for third party logistical services,” *International Journal of Physical Distribution & Logistics Management*, Vol. 40 No.1/2, pp. 84-102.
- World Economic Forum (2008), *Global Risks 2008: A Global Risk Network Report*, <http://www.weforum.org/>, [accessed 12/07/09].
- Zhu, Q. and Sarkis, J. (2004), “Relationships between operational practices and performance among early adopters of green supply chain management practices in Chinese manufacturing enterprises” *Journal of Operations Management*, Vol. 22, pp.265-289.

**Supply Chains for the Management of Post-Consumer Apparel Waste:  
Three Scenarios Addressing the UK-Tanzania Context**

**Track 4f: Development, Globalisation, Emerging Markets, Sustainable Global Product  
Chains**

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**Introduction**

This paper explores three alternative supply chain scenarios for post-consumer apparel waste from a global perspective. Used clothing is considered from a UK and Tanzanian perspective. The scenarios are outlined and material flows, economic, environmental and social costs and benefits are discussed.

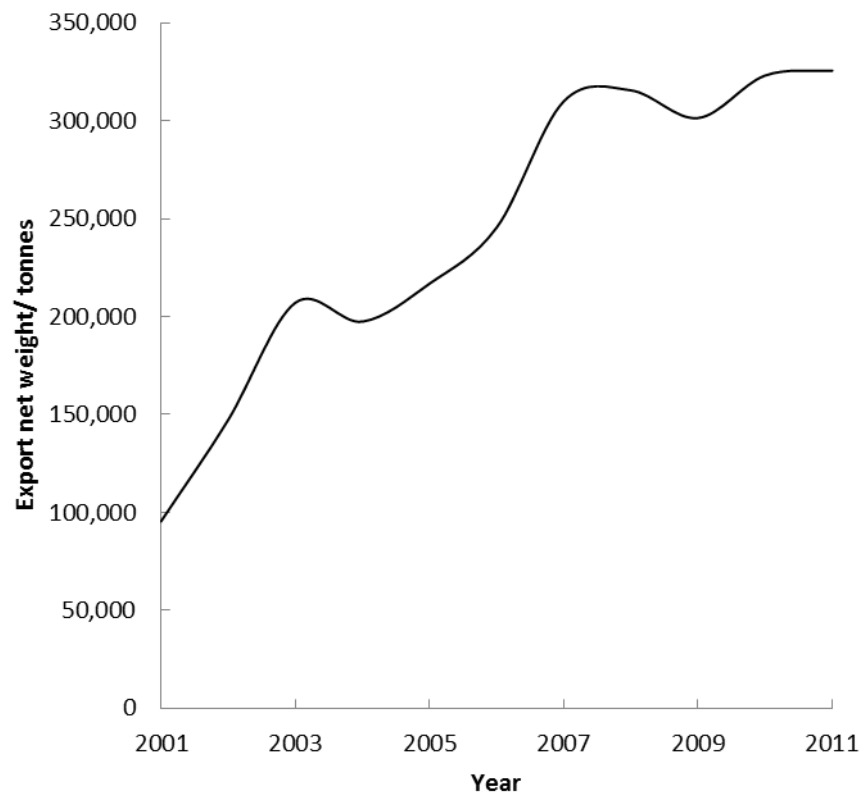
***Used clothing in the UK***

Fashion consumption in the UK is increasing rapidly. The average consumer now purchases over fifty items of clothing per annum (Carbon Trust, 2011). The product lifecycle is designed to be short; the industry remains economically viable due to continuous change. The rise of the 'fast fashion' phenomenon has shortened lifetimes further. Reducing lead times bring products to the market quickly, dispensing with the concept of seasonality and ensuring high-street stores can offer the consumer a new look monthly, at relatively low cost (Barnes & Lea-Greenwood, 2010). With growing consumption comes growing disposal; approximately 2 million tonnes of clothing are disposed of yearly in the UK (DEFRA, 2011).

Post-consumer apparel which is diverted from landfill may be reused as clothing, recycled into other products or incinerated in energy-from-waste (EfW) plants. The reuse and recycling markets are supported by secondary industries in the UK. Charities, local authorities and private companies collect used clothing via door-to-door collections, textile banks, kerbside collections and direct donation. The received items are sorted and graded according to appropriate end-use. The most profitable end-use is resale in the UK, which accounted for ~20% of donated materials in 2008. There is a much larger overseas reuse market; approximately 40% of used clothing collected in the UK in 2008 was exported, mainly to Eastern Europe and sub-Saharan Africa (Morley *et al*, 2009). The export trade in

used clothing has increased considerably in recent years. Figure 1 shows the variation in export net weight from the UK to the rest of the world in the period 2001 – 2011.

The export market is prone to fluctuation the ongoing controversy regarding whether some exported used clothing should be subject to the Trans-Frontier Shipment of Waste (TFS) Regulations may affect this flow further. Morley *et al* (2009) discuss the complexity of.



**Figure 1: Variation in export net weight of used clothing from the UK to the rest of the world (2001 – 2011). Source: Comtrade.**

defining what constitutes a waste textile. Essentially, clothing donated with the intention that it should be reused (for example, charity shop donations) does not constitute waste and is exempt from TFS Regulations. However, materials deemed unsuitable for resale (for example, the fraction of a donation leaving a charity shop without being resold) is considered to be waste, as it is deemed only suitable for recycling or disposal

Recycling grade materials are classified as waste until they have been processed into a secondary product and are subject to TFS Regulations.

Under TFS regulations, textiles are considered a Green List waste and can be sent to EU Member States and OECD countries under Green List controls. Export to non-OECD countries is more complex; in this case, the exporter is responsible for checking that the destination country is willing to receive the recyclable waste and establish the conditions for export.

In recent years, the textile sorting industry in the UK has declined. Export of unsorted goods to lower-labour cost countries for sorting has increased. Unsorted textiles contaminated with other materials such as plastic and food (common in textile bin collections) cannot be shipped under Green List controls. It has been suggested that the resulting export delays and associated costs may affect the profitability of overseas sorting (Morley *et al.*, 2009).

The recycling market in the UK is currently much smaller than the export market. In 2008, 23,000 tonnes of used clothing was recycled in the UK and 52,000 tonnes exported for recycling in lower-labour cost countries (Morley *et al.*, 2009). However, estimates from textile collectors suggest that the recycled fraction is increasing, particularly in textile bank collections (Barry, 2012). There are a multitude of recycling grades, dependent on material characteristics and textile integrity. The major categories for UK post-consumer apparel are rags and wipers, self-colour and jazz for export and flocking.

If the textile is suitably absorbent, it may be torn into rags and wipers in a low-energy, low-cost process. In recent years the UK market for these goods has declined as a result of the demise of UK heavy engineering and global technological change in the printing industry. This decline is reflected in the low value of the resulting materials. The price per tonne for wipers is around £100, compared to £1,100 for the sub-Saharan African reuse market (Morley *et al.*, 2009).

There is an export market in India for self-coloured knitted wool and mixed fibres, and jazz grade materials (typically loosely-knitted fabrics from which longer-length fibres can be recovered and re-spun into yarns). These are converted by shoddy manufacturers into blankets (Norris, 2005).

Flocking is the mechanical ‘downcycling’ of the remaining post-consumer apparel waste into filling materials. The most common end-use for these products is in mattresses and upholstery, for which a high proportion of wool is desirable (its natural fire-retardant properties negates the need for synthetic additives). A textile re-processor interviewed in the course of this work produced three flock products consisting of 80%, 40% and 10% wool respectively. The remaining proportion may be a blend of any fibres, but is usually high in polyester, reflecting the typical composition of UK used clothing (Mulligan, 2012). The UK flocking industry is small in relation to the volume of used clothing generated. Only three flocking plants remain in the UK (Norris, 2012). It is also a relatively low-value industry. Although the price of rag rose progressively between 2005 and 2009, Morley *et al.*, (2009) quote an average price per tonne for flocking of £50.

The low value of the products arises from the heterogeneity and construction of the textile materials, together with the perceived diminishing of the ‘quality’ of UK clothing associated with fast fashion. Interviews with two major textile collectors revealed that the volume of textiles deemed unfit for reuse has increased in recent years. One sorter estimated that recycling grades have grown from 30% to 50% in the last five years (Barry, 2012).

Where materials are homogeneous, there are examples of higher-value recycled products. For example, Japanese company Teijin Fibres have developed ECOCIRCLE<sup>TM</sup>, a closed-loop

polyester recycling scheme in which appropriate polyester-rich garments can be recycled back into fibre grade polyester. Although this is a high-energy process, it still affords substantial environmental savings in comparison to production of virgin polyester (Morley *et al*, 2009). However, separation of the intimately-mixed blends found in clothing is extremely difficult. Research has been undertaken into the separation of cotton and polyester (see, for example, Ouchi *et al*, 2010) but the low price of virgin polyester has not encouraged commercialisation.

Post-consumer apparel which is not reused or recycled may be incinerated in EfW plants. One major collector disposes of its unusable goods in this manner (Needham-Brinley, 2012). Textiles have a high calorific value and are therefore desirable as part of an EfW waste stream, provided the technological issues surrounding their incineration are dealt with. In untreated form, waste textiles are not always well-suited to incineration; large quantities may ‘clog’ the centrifuge, lowering the efficiency of the EfW plant (Dahloff, 2004) and long threads from textiles may act as ‘fuses’ between the furnace and waste store, causing uncontrolled combustion of the waste store. However, pre-treatment of waste by cutting and shredding avoids these issues (Palm, 2011).

Despite these alternatives, and the disincentive in the form of the Landfill Tax, landfill remains the predominant end-of-life fate for discarded clothing in the UK. Approximately 1 million tonnes enter landfill yearly (DEFRA, 2011) in comparison to around 500,000 tonnes that are recovered for reuse and recycling (Morley *et al*, 2009). The environmental impact of textiles in landfill is disproportionately high; as well as direct emissions, there are embodied emissions from the upstream processes of fibre and textile production, manufacturing and transport (Jorgensen *et al*, 2006).

### ***Used clothing in the United Republic of Tanzania***

In 2010, over 600,000 tonnes of used clothing were exported from the Global North to sub-Saharan Africa (Comtrade, 2012). Table 1 shows the major destinations for used clothing in 2010. The United Republic of Tanzania (referred to hereforward as ‘Tanzania’) was the tenth-largest importer by weight for used clothing and second only to Ghana in sub-Saharan Africa.

Country	Import net weight of ‘worn clothing and other worn articles’ (HS6309) from ‘world’ / kg
Pakistan	293,512,439
India	250,402,976
Canada	204,979,988
Malaysia	132,954,217
Netherlands	108,441,931
Ghana	100,498,101
Ukraine	91,306,606
Cambodia	87,062,631
Spain	83,754,250
United Republic of Tanzania	80,236,213

**Table 1: Top ten importers of ‘worn clothing and other worn articles’ in 2010. Source: Comtrade.**

The import of used clothing to Tanzania from the rest of the world has almost doubled in the last ten years: in 2001, 48,719 tonnes were imported; by 2011, this had risen to 87,288 tonnes (Comtrade, 2012). Used clothing is popular as it allows the Tanzanian consumer to develop a unique identity at an affordable price (Rivoli, 2009).

It can also generate employment for micro-, small- and medium-sized enterprises in the textile sector, who tailor the clothing to meet consumer needs (Mahwera, 2009).

Critics of the used clothing trade argue that it has undermined domestic textile industries in sub-Saharan Africa. Certainly, in the 1980s, textiles was the largest manufacturing sector in Tanzania. However, it was heavily subsidised; post-liberalisation, a lack of investment forced many companies to close (Mahwera, 2009). Government corruption, the growth in cheap imports following the expiration of the Multi-Fibre Agreement (MFA) and a lack of sensitivity towards consumer wants and needs have also contributed to the decline of the domestic industry (Baden and Barber, 2005; Bahadur *et al*, 2004; Mkenda, 2005; Hansen, 2000; Hawley, 2008). If the Tanzanian textile industry is to be reinvigorated, it is necessary to find new markets in which extant skills can be utilised.

Little is known of the end-of-life fates of textiles in Tanzania, giving rise to concern that the used clothing trade may generate environmental problems in countries less well-equipped to deal with them. It is estimated that less than 40% of the total municipal solid waste (MSW) stream is collected in Dar-es-Salaam (Lavagnolo, 2010). The remaining waste is disposed of locally, often through uncontrolled dumping. MSW collections are not separated into individual stream, and landfill is the dominant disposal method. An informal labouring sector of ‘wastepickers’ recover and sell valuable materials from landfills and dumps. There are also some community-based recycling organisations who aim to promote recycling, but neither consider textiles worthy of recovery (Palfreman, 2010; Uiterkamp *et al*, 2011).. The fraction of textiles in the waste stream is not known.

### ***Used clothing – the UK: Tanzania context***

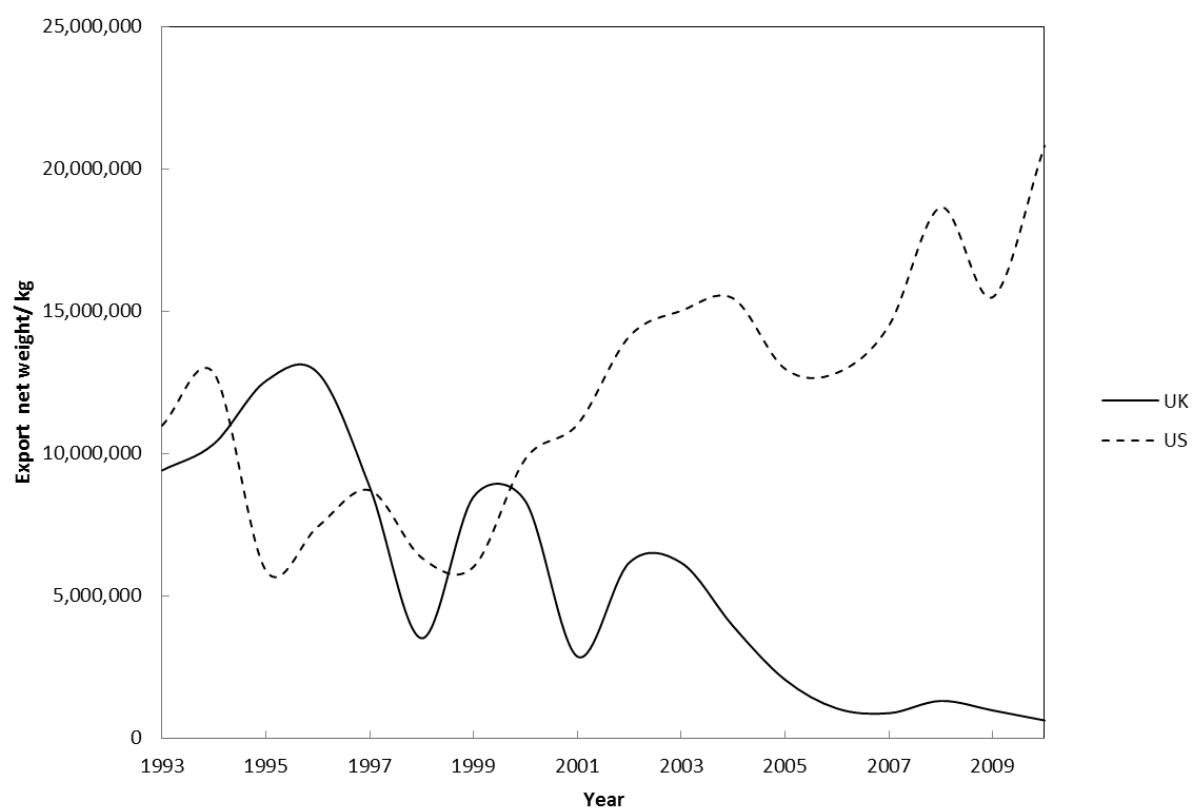
In recent years, exports of used clothing from the UK to Tanzania have declined. Telephone enquiries to members of the UK Textile Recycling Associating failed to identify any exporters currently working with this market.

This decline may be attributed to a number of factors. Firstly, running parallel to the decline in the UK is an upsurge of imports from the USA, now the largest by weight used clothing importer to Tanzania. US used clothing is competitively priced; the average price per kg (including overheads) in 2010 was \$0.57, compared to \$0.73 for UK goods. In addition, interviews with two major UK-based textile sorters revealed that the Tanzanian market prefer the more casual fashions found in the US (Barry, 2012; Brinley-Needham, 2012).

Figure 2 shows the change in export weight from the UK and US to Tanzania over the nineteen-year period 1993 – 2001.

Competition from ‘virgin’ unused clothing imports also plays a role. China imported clothing worth \$17,976,534 into Tanzania in 2010, 61% of the total import market (Comtrade, 2012). Historically, quality of imports has been poorer than that of used clothing (Rivoli, 2009; Brooks, 2012). However, sub-Saharan Africa is a rapidly-developing economy. Consumer expenditure was almost \$600 billion in 2010 and is predicted to be in the region of \$1 trillion by 2020 (Hatch, Becker and van Zyl, 2011). As the more rapidly developing countries attract increasing attention as emerging markets, consumer demands for higher quality goods are likely to gain credence.

The sub-Saharan African market is also highly volatile. In some countries, concern over the impact of used clothing on the indigenous textile industry has led to import restrictions and bans (Baden and Barber, 2005). The drop in used clothing exports from the UK and US in



**Figure 2: The change in exported ‘worn clothing and other worn articles’ from the UK and the US to the United Republic of Tanzania. (Source: Comtrade, 2012)**

1998 observed in Figure 2 corresponds to an increase in import tax and VAT for used clothing levied by the Tanzanian government. Further, the government is currently debating whether to introduce further restrictions on used clothing import (Ruta, 2012).

Fluctuating markets, legislation, quality degradation and unknown environmental impacts indicate there is a pressing need to identify and implement economically-viable and environmentally considerate end-of-life management of post-consumer apparel waste both in the UK and Tanzania. The remainder of this paper is given over to discussing three scenarios which may address the issues outlined.



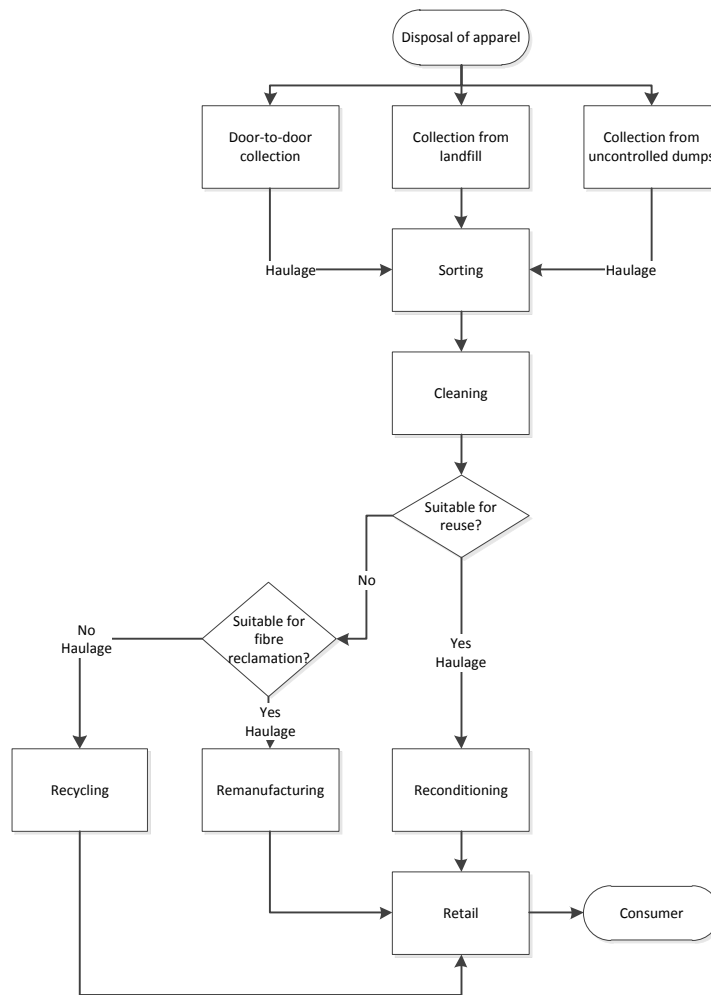
## Scenario 1: Low-technology solutions for Tanzania

Innovation is often measured via technological advancement. However, a new idea or method can be produced with indigenous knowledge and utilising local conditions (Lal and Mhohnen, 2009). There is evidence of low-technology textile innovation in a number of developing economies. For example, in India strips of waste saris are tied together to make longer lengths suitable for hand-guided weaving into rugs and bedcovers (Gupta and Khare, 2011). In Tanzania, small quantities of textiles collected by wastepickers may be used as fillings for locally-produced pillows, but this has little commercial value (Kaseva and Gupta, 1996; Skat Foundation, 2003). By contrast, the demand for waste plastic bottles for recycling into fibre in Japan and China provides a lucrative market for wastepickers. Recently, in order to realise the environmental, social and economic benefit of recycling locally, a United Nations project has established a demonstration centre for converting plastic waste into chips. Stakeholders include community-based organisations which support wastepickers. The demonstration centre has encouraged sector-led supply chain innovation in which plastic companies work alongside recycling entrepreneurs (UNIDO, 2012).

In this scenario, we propose a similar framework for the collection and utilisation of post-consumer apparel waste. Wastepickers collaborate with the private waste collection sector in Dar es Salaam in order to separate textile waste from collections prior to landfilling. Post-separation, three routes are proposed: in the first, textiles suitable for reuse are supplied to designers for adaptation or remanufacture; in the second, the textiles undergo fibre reclamation and are reprocessed into knitted and woven fabrics; in the third, the textiles are mechanically recycled into technical nonwovens to support the horticulture and floriculture industries.

The proposed supply chain is illustrated in Figure 3. The supply chain begins with apparel disposal. Three modes of disposal are considered; via the municipal solid waste stream to landfill, via uncontrolled dumping or via a newly-implemented separate textile collection by a community-based recycling organisation.

In the case of disposal direct to landfill or dumps, the existing wastepicking sector could be utilised to work collaboratively. When wastepickers work collaboratively, it directly improves their incomes, working conditions and self-worth. Economic benefits are realised for local councils through a reduction in the cost of solid waste management and social benefits arise from the improvement of the urban environment (Medina, 2005). Thus, adding textiles to the waste streams valued by wastepickers will be of benefit, irrespective of the volume collected. However, textiles are easily contaminated in mixed collections which can reduce their potential value (Morley *et al.*, 2009). Door-to-door collections of textiles in conjunction with community-based organisations would realise the best value from the materials. Capital costs would be low in comparison to other collection methods (for example textile bin collections). Social and economic benefits would arise from employment opportunities in collection. Social costs may arise from the perceived invasion of privacy from door-to-door collections, but this may be offset if the scheme is promoted in the community and are scheduled for regular days and times. Social and environmental costs



**Figure 3: A proposed supply chain for the realisation of value from post-consumer apparel waste in Tanzania.**

may also arise from transporting the textiles from villages to their end-destination, although this is likely to be small for community-based organisations who typically use handcarts or small vehicles to transport waste. Door-to-door collection may also encourage householders to dispose of textiles which may otherwise be stored or burnt.

Once collected, the textiles must be sorted for their appropriate end-use and cleaned. This may be carried out by wastepickers or community-based recycling organisations. Even in developed economies, sorting is usually a manual, low technology, hands-on process. Appearance, handle, quality and composition all influence future use (Barry, 2012; Needham-Brinley, 2012; Hawley, 2008). Sorting and clearing requires space. In addition, materials only suitable for recycling will require storage until sufficient volume has been collected. The economic cost could be shared between co-operatives of wastepickers and community recyclers. Environmental and economic costs arise from the laundering of the materials in this stage.

Clothing suitable for direct reuse will be transported to tailors for adaptation and resale. Environmental costs arise from transport, although this may be kept to a minimum, given that there are unlikely to be large volumes. Economic benefit is realised by the wastepicker and

the tailor in a mutually-supportive micro-supply chain. It should be noted that this waste fraction is likely to be extremely small (anecdotal evidence suggests clothes are worn until threadbare by most Tanzanian consumers). However, wastepickers and tailors can also realise economic benefit by removal of notions (buttons, zips etc.) from other garments for reuse in new designs. This is a slow manual process which is not economically viable in developed economies. Reuse benefits are of the order of 33kg CO<sub>2</sub> equivalents per tonne for cotton and polyester clothing compared to virgin clothing production (Morley *et al*, 2006).

Where clothing is not suitable for reuse as a garment, but the textile still has some integrity, tailors or other craft-based designers may gain economic benefit through remanufacture of the textile into other goods. In India, scraps of materials are turned into wash-bags, hair accessories, shoulder bags and patchwork clothing for the domestic and export markets (Norris, 2010). A lifecycle assessment carried out by Zamani (2011) suggests that remanufacture saves approximately 7000kg CO<sub>2</sub> –equivalents per tonne compared to manufacture from virgin materials.

Textile not suitable for remanufacture may follow either a design-led or technology-led route. The Indian shoddy industry provides a useful framework for a design-led solution. Economic costs would arise from setting up mills; since the Tanzanian textile industry is based on cotton, modification of existing or purchase of new equipment would be necessary. Environmental costs (energy, emissions to air and water) would arise during production, although emissions to water would be minimised if textiles were sorted by colour before reprocessing, dispensing with the need for a dyeing stage. These environmental costs would be substantially lower than the production of virgin textiles through displacement of fibre production. Social benefits would be realised through employment opportunities. If the mill were to rely only on recovered materials, irregular flow would pose a business risk. However, import of appropriate materials from developed economies would support Tanzanian industry and provide new markets for collectors and sorters; this trade would be subject to TFS regulations.

However, most used clothing in Tanzania is imported as part of a ‘tropical mix’, which is predominantly woven cotton (Needham-Brinley, 2012). Shredding these materials gives very short fibres. Although respinning technology already exists in Tanzania, the resulting low-quality cotton would have limited value. Instead, we propose a technology-led solution which supports the flourishing agriculture and floriculture industries (Mbuligwe *et al*. 2002). Intensive cultivation in Tanzania has led to deforestation and land degradation (LEAT, 2012). Coconuts are a major crop in Tanzania; coir fibre obtained from them is being converted to needlepunched nonwoven blankets in Indonesia (Tatkis, 2007). These break off run-off in heavy rains and provide barriers to erosion and weed growth. Similarly, sisal is grown throughout Tanzania. This may be converted into a needlepunched nonwoven for hanging-basket liners, adding value to the floriculture market (Mulligan, 2012). Investment in nonwoven equipment would allow both these markets to be realised and provide environmental, economic and social benefits. Small amounts of post-consumer waste could be incorporated in either case, or 100% post-consumer apparel waste materials could be produced on the same equipment to produce low-value materials for the automotive and

carpet industries. Utilising the UNIDO model in the setting-up of a nonwoven demonstration centre may invite investment in such technology. Environmental and social benefits arise from the avoidance of landfill and production of virgin material, and from the potential this offers in tackling the effects of land degradation. The environmental costs in terms of energy and emissions to air are small in comparison to the benefits afforded.

## **Scenario 2: A high-technology solution for the UK**

This scenario considers how the UK can obtain higher value from post-consumer apparel waste, addressing the issues caused by the increase of recycling grade material observed in the UK.

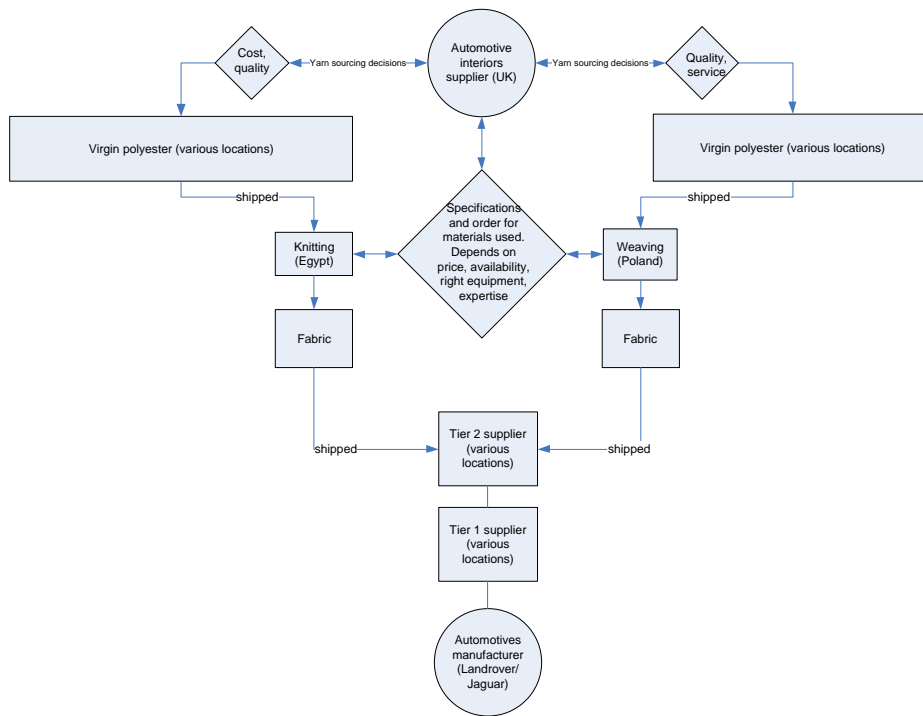
In recent years there has been an increase in synthetic fibres in clothing, particularly polyester. Polyester and its blends have been identified as problematic recycling grades, only being suitable for low-value applications such as flocking or shoddy (Morley *et al*, 2009). Here, we suggest that chemical recycling of polyester blends may yield materials suitable for higher value markets.

One potential recipient of recycled polyester is the automotive industry. Legislation such as the European Union End of Life Vehicles Directive, together with rising consumer awareness regarding the environmental impact of personal vehicles has encouraged automotive manufacturers to seek more environmentally-friendly materials and processes (Nunes & Bennett, 2010). As the automotive market becomes increasingly segmented in response to consumer demand (Dicken, 2011), some manufacturers have developed an ‘eco-segment’ in which green design strategies are applied to all vehicle components. For example, Ford uses sustainable fabrics in any vehicle with an eco-friendly powertrain. The Ford Focus Electric employs Unifi’s Repreve®, a 100% recycled polyester made from a blend of post-consumer plastic drinks bottles and post-industrial polyester fibre waste (Unifi, 2012).

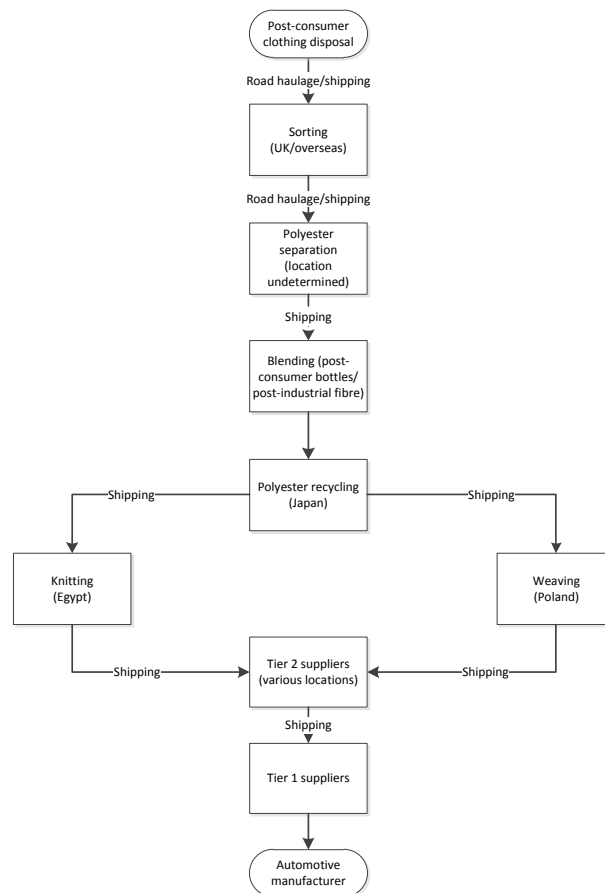
In order to analyse the potential for the incorporation of post-consumer textile waste in automotive interiors, the design and manufacture of a UK-based automotive interiors supplier were investigated through a series of interviews. Figure 4 illustrates these processes.

The company do not have a manufacturing footprint; toll manufacturing arrangements exist with a number of textile producers. Their core competencies lie in design and supply-chain management.

It can be seen from Figure 4 that the company currently use virgin polyester yarns. Replacement with post-consumer apparel waste would require a supply chain similar to that illustrated in Figure 5, which includes the polyester pre-processing stages. Although these are not managed directly by the automotive interiors company, they impact both financially and environmentally on the final product. We discuss only the stages up to textile manufacture here.



**Figure 4: A generalised overview of the design and manufacturing process of a UK automotive interiors supplier.**



**Figure 5: A proposed supply chain for the use of polyester from post-consumer apparel for an automotive interiors manufacturer.**

The first step in the supply chain is the collection of clothing waste for further reprocessing. Existing charity and private collection systems may be utilised if the market can be demonstrated to add value. Currently, there is a conflict between collector priorities and the need to divert more textile waste from landfill in that recycling polyester grades are of low value. More valuable end-markets for these will encourage textile collectors to promote the recycling side of their businesses. Social, environmental and economic benefits arise from diversion from landfill. The environmental impact of transportation for sorting is likely to be offset by the avoidance of transport to, and gaseous emissions from landfill.

Materials suitable for this supply chain may come from two sources: polyester-rich material which is not suitable for reuse; and polyester-rich materials currently being exported to sub-Saharan Africa. With the exception of sports shirts, high percentage polyester garments are not particularly desirable to this market, although they may be included in tropical mixes when other end-markets are not available (Barry, 2012). Existing sorting processes are manual; skilled workers can easily detect poly-cotton blends by eye. However, it may be that the economics of recovery dictate that blends must contain a minimum percentage of polyester to be suitable for chemical recycling. Other materials such as elastane also affect recyclability. Current sorting methods may not be appropriate, therefore. Dutch organisation 'Textiles4Textiles' have developed an automated sorting system using near infra-red (NIR) to sort textiles by composition and colour as part of an EU-funded Eco-Innovation project (Textiles4Textiles, 2012). Technically, then, more accurate sorting can be undertaken. However, the investment required to implement such a system is significant and requires both a higher throughput of used clothing and clear value-added markets before it can be considered economically viable for UK-based sorting companies (Barry, 2012).

The polyester used in automotive textiles is of high quality. Automotive manufacturers are highly risk-averse; buying a car is a high-involvement purchase decision and negative word-of-mouth can impact on sales and lower the chances of repeat purchase. Therefore, textiles undergo rigorous testing covering factors such as abrasion resistance, burst strength, cleanability, colour fastness, fibre deterioration, flammability, pilling, shrinkage, tear strength and tensile strength. Suppliers not meeting the appropriate criteria run the risk of losing repeat business from the automotive manufacturer. Any polyester obtained from post-consumer clothing must therefore be as pure as possible to be acceptable to the market. This poses a significant technological challenge. Acid hydrolysis followed by mechanical treatment has been shown to separate polyester and cotton cleanly and effectively. This is a relatively low-cost process, requiring less chemicals and energy than competing processes (Ouchi, 2010). To date, there is no commercial separation process; costs and environmental impacts of implementing one are not clear, and this is an area requiring further investigation. Should commercialisation be feasible, this may be a potential area for investment for existing polyester recyclers such as Teijin, who could realise economic benefits from a greater throughput of polyester.

Typically, automotive grade polyester is of higher quality than clothing fibres. It is likely that after separation it will require blending with other post-consumer and post-industrial waste streams. Most polyester recyclers already blend multiple waste streams as part of their

process; hence, there would be no additional capital costs incurred in this stage. Social and environmental benefit arises from the diversion of all feedstocks from landfill and incineration. Significant energy and carbon dioxide savings arise for chemical recycling in comparison to the production of virgin polyester (in the order of 70 – 80% and 70 – 75% respectively, dependent on transport involved in collection for reprocessing). The cost of recycled fibres is typically 10 – 20% greater than for virgin polyester owing to the costs of collection, sorting, equipment and process costs (Morley *et al.*, 2009). The additional separation step for post-consumer apparel waste will bring about additional economic costs. Blend proportions will be dependent on the quality of polyester reclaimed from the post-consumer clothing and investment into research and development would be necessary to establish the best blend for the automotive industry. There is also the question of gaining approval from the automotive manufacturers, who are notoriously resistant to change in the supply chain. It takes five years or more for a new supplier to gain acceptance with an established automotive manufacturer. The automotive industry is also very cost-sensitive. However, an empirical survey carried out on 106 European automotive consumers by Hetterich *et al.* (2012) identified that 36% of participants were willing to pay an additional €1000 for an automotive interior made from recycled materials. Whilst this study did not address the attitude-behaviour gap evident in other consumer markets, it indicates that external costs may be absorbed by the consumer in eco-segments.

Social and environmental benefits for this process are largely related to the diversion of materials from landfill and energy for waste systems and avoidance of virgin fibre production. Additional benefits arise from employment in the sorting and separation stages. Social and environmental costs are dependent on the cleanliness of the separation process.

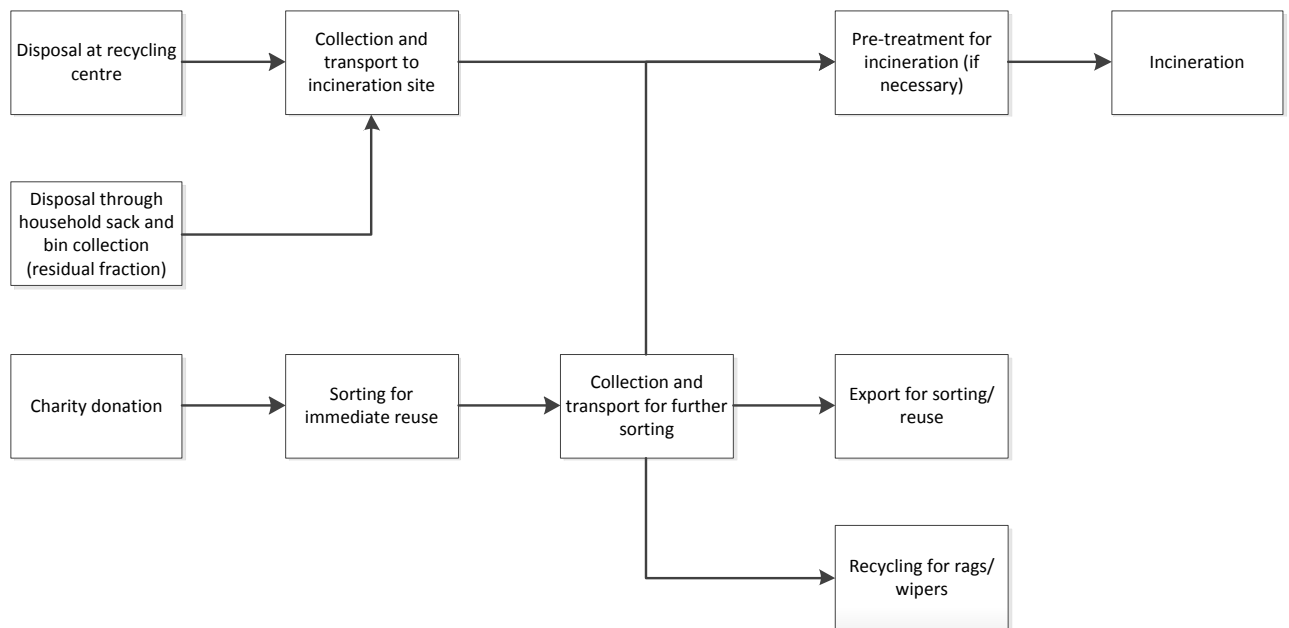
### **Scenario 3: Energy from Waste from waste textiles in the UK.**

In the third scenario, we consider the role of EfW in the effective treatment of post-consumer apparel waste. For many years, the UK has relied primarily on landfill for waste management. In contrast, the predominant waste treatment choices in Sweden are recycling and incineration (Corvellec & Hultman, 2012). In the 1970s, incineration was the favoured choice; a vast infrastructure of municipal district heating systems was developed to gain heat from waste (Corvellec & Hultman, 2012). However, in recent years, Sweden has promoted recycling of waste. In 1994, extended producer responsibility was introduced for packaging, vehicles, newsprint, tyres, and electronic and electrical equipment, supported by household recycling schemes for metal, glass, paper and plastic packaging (Bernstad *et al.*, 2011). In 2000, the Swedish government introduced a landfill tax, followed by a ban on combustible material in 2002 and organic waste in 2005. Since the 1970s, Sweden has moved from a position of almost 100% landfill of municipal waste to a mere 3% (Corvellec & Hultman, 2012).

The average Swedish resident disposes of 22 kg of clothing and textiles each year (Mistra, 2010). Of this, 53% is incinerated in EfW systems, 20% collected for reuse and the remainder is either dealt with through other waste management technologies or stored in wardrobes (Palm, 2011). Textile recycling has not been undertaken on an industrial scale

since 1992; nor is there significant export for recycling in lower labour-cost countries. There is a small trade in rags for industrial wipers, but on the whole textile recycling is not economically viable (Palm, 2011). As in the UK, there is no household recycling system for textiles. Several charities collect used clothing through door-to-door collections and textile banks.

Figure 6 shows the post-consumer supply chains for used clothing in Sweden. The figure assumes that materials sorted from charity donations which are not useful for rags and wipers are disposed of through incineration. Materials in home sack and bin and other recycling centre collections are assumed to go direct for EfW.



**Figure 6: Post-consumer supply chains for used clothing in Sweden (based on Palm, 2011).**

In comparison to the fraction of textiles currently landfilled in the UK, the Swedish model has two main environmental advantages. A study of greenhouse gas (GHG) emissions generated when making recycled polypropylene products modelled the carbon dioxide equivalents for the case of avoided combustion and the case of landfill avoidance. Landfill avoidance was found to save 9.2 tonnes CO<sub>2</sub>eq., whilst avoided combustion saved 6 tonnes CO<sub>2</sub>eq (Michaud *et al.*, 2010), suggesting that the associated costs of landfill are greater than those for incineration. Energy generated by EfW plants can also replace that generated by fossil fuels. Each tonne of municipal waste incinerated saves approximately one barrel of oil or 0.26 tonnes of coal (ISWA, 2006). The energy used in incinerating clothing is negligible by comparison to the energy gained due to the high calorific value of the material (Zamani, 2011).

On the other hand, the absence of industrial recycling in Sweden increases the environmental impact of the disposal stage. Textile recycling is environmentally preferable to incineration in terms of GHG emissions, especially when virgin textile production can be avoided in which case approximately 4 kg CO<sub>2</sub>eq. per kg of clothing (Michaud *et al.*, 2010; Morley *et al.*,



2006). The UK mechanical recycling industry uses similar processes to the incineration pre-treatment process, so is comparable in environmental impact. Recycling also saves most of the sulphur dioxide and dioxin emissions associated with incineration (Ares and Bolton, 2002). Jamasb & Nepal (2010) also cite congestion from waste transport as a potential environmental impact, although this will be offset by the environmental cost of transportation to the recycling facility.

Economically, post-consumer apparel waste incineration in Sweden requires very little additional financial outlay. There is no need for a separate household collection, pre-treatment is not always necessary and when it is undertaken it is a low-cost procedure comparable with the costs of sorting for reuse and recycling. The charity collection model is similar to that in the UK, and will have similar economic costs and benefits. Conversely, the main economic concern in adopting the Swedish model in the UK would be the financial costs associated with developing an EfW infrastructure. There are substantial costs associated with the development of EfW plants (Jamasb & Nepal, 2010). Although incineration is receiving increased interest in the UK (indeed, one major collector already sends the bottom 5% of their collections for EFw), a network does not yet exist and would be expensive to implement. Whilst EfW recoups cost from gate fees, energy sales, recycling of non-combustibles and sale of post-combustion residues, the time taken to recoup the initial costs is significant (Jamasb & Nepal, 2010).

Compared to landfill, EfW has social benefits. Space requirements are small compared to landfill, the energy generated can provide a degree of energy security and plants can provide employment for the local area. However, EfW remains an unpopular option for the general public. Newspaper reports indicate that protests have been launched against planning applications for eighty EfW plants in the UK (The Times, 2012). Local residents may object to EfW plants on the grounds of unsightliness, odour and health concerns arising from increased traffic and emissions. Nonetheless, EfW is receiving much attention from the UK government, with a guide for Energy for Waste expected in 2012 covering anaerobic digestion and incineration (DEFRA, 2012).

There has been much discussion regarding the relationship between EfW and recycling. Advocates claim that the two processes can co-exist, citing high recycling and incineration rates in countries such as Sweden (Jamasb & Nepal, 2010). This is broadly true but does not take into account the role of extended producer responsibility in achieving high rates of recycling. In Sweden, high rates of recycling are seen for those streams collected separately; textile reuse and recycling accounts for only 20% of the total post-consumer apparel waste stream (Palm, 2011). This is comparable to the percentage collected for reuse and recycling in the UK (Morley *et al.*, 2009), whilst the UK's performance for other waste streams is much lower. The inference is that neither country has optimised the end-of-life options for post-consumer apparel waste. Morley *et al.*, (2006) could find no strong justification for extended producer responsibility for waste textiles because of their relatively low end-of-life pollution potential. The question arising for the UK is to what extent the introduction of EfW may detract from existing routes for recycling without such measures in place. Carefully developed voluntary guidance and an infrastructure promoting the reuse, recycling and

incineration pathways as being mutually-supportive would be necessary. Separate household collections would almost certainly increase the volume of textiles diverted from landfill, but the high costs and low perceived benefits make such collections unlikely in the near future. Equally, a rapid increase in the volume of recycling grades may overwhelm the existing textile recycling infrastructure (Morley *et al*, 2006). Without the development of new value-added markets as outlined in Scenario 2, the most appropriate end-of-life option for textiles would be a combination of recycling and EfW.

## **Conclusion**

The three scenarios outlined here all realise significant benefits over landfill either in sub-Saharan Africa or in the UK. It is clear that one end-of-life strategy does not fit all. Of the scenarios, an integrated reuse and recycling scheme in Tanzania affords the most significant social, environmental and economic benefits. The other scenarios face both technical and financial challenges to realise, but provide useful indications for future directions in post-consumer apparel waste management.

## **References**

- Ares, E. & Bolton, P. (2002) Waste Incineration. House of Commons Library. House of Commons: London.
- Baden, S. & Barber, C. (2005). The Impact of the Second-Hand Clothing Trade on Developing Countries. Oxfam.
- Bahadur, A., Koen, M. & Mthembu, N. (2004). Developing a Strategic Response to the Trade in Used Clothing in Africa. Durban: ITGLWF Africa.
- Barnes, L. & Lea-Greenwood, G. (2010). Fast Fashion in the Retail Store Environment. *International Journal of Retail and Distribution Management*, 38 (10), 760 – 772.
- Barry, L & R. Personal Interview. L. M. Barry Recycling. February 2012: London.
- Bernstad, A., Jansen, J. La Cour and Aspegren, H. (2011). Lifecycle Assessment of a Household Solid Waste Source Separation Programme: A Swedish Case Study. *Waste Management and Research*, 2011 29: 1027.
- Brooks, A. (2012). Stretching Global Production Networks: The International Second-Hand Clothing Trade. Environment, Politics and Development Working Series, Department of Geography, University of Kings' College, London.
- Carbon Trust (2011). International Carbon Flows – Clothing (CTC-793) [online]. Available from <http://www.carbontrust.co.uk/publications/pages/publicationdetail.aspx?id=CTC793> [Accessed 22/05/2012]
- Comtrade (2012). United Nations Commodity Trade Statistics Database [online]. Available from <http://comtrade.un.org> [Accessed 22/05/2012].

- Corvellec, H. and Hultman J. (2012). From “Less Landfilling” to “Wasting Less”: Societal Narratives, Socio-materiality, and Organisations. *Journal of Organisational Change Management*. Vol. 25, Issue 2: pp. 297 – 314.
- Dahlloff, L. (2004). Methodological Issues in the LCA Procedure for the Textile Sector: A Case Study Concerning Fabric for a Sofa. Chalmers University of Technology: Sweden.
- DEFRA (2011). Sustainable Clothing Roadmap – Progress Report 2011 [online]. Available from <http://www.defra.gov.uk/publications/2011/06/02/pb13462-clothing-roadmap> [Accessed 22/05/2012].
- Dicken, P. (2011). ‘Wheels of Change’ The Automobile Industry. In *Global Shift: Mapping the Changing Contours of the World Economy*. 6<sup>th</sup> Edition. London: Sage.
- Gupta, V. and Khare, A. (2011). Value Creation in Post-Consumer Apparel Waste: A Study of Urban Rural Dynamics in India. Working Paper, University of the Arts, London.
- Hansen, K. (2000). *Salaula: The World of Second-Hand Clothing and Zambia*. Chicago: University of Chicago Press.
- Hatch, G., Becker, P. and van Zyl, M. (2011). The Dynamic African Consumer Market: Exploring Growth Opportunities in Sub-Saharan Africa. Accenture.
- Hawley, J. (2008). *Economic Impact of Textile and Clothing Recycling*. New York: Fairchild Books Inc.
- ISWA (2006). International Solid Waste Association. *Energy from Waste: State of the Art Report: Statistics*. 6<sup>th</sup> Edition. August 2006.
- Jamasb, T. & Nepal, R. (2010). Issues and Options in Waste Management: A Social Cost-Benefit Analysis of Waste to Energy in the UK. *Resources, Conservation and Recycling*, 54, 1341 – 1352.
- Jorgensen, U., Olsen, S. I., Jorgensen, S. M., Hauschild, M., & Hagelskjaer, L. (2006). *Waste Prevention, Waste Policy and Innovation*. Technical Institute of Denmark, Department of Manufacturing Engineering and Management (IPL). Lyngby: Department of Manufacturing Engineering and Management, Technical Institute of Denmark.
- Kaseva, M. and Gupta, S. (1996). Recycling – An Environmentally Friendly and Income Generating Activity Towards Sustainable Solid Waste Management. Case Study – Dar es Salaam City, Tanzania. *Resources, Conservation and Recycling*, 17, 299 – 309.
- Lavagnolo, M. (2010). A Glance at the World. *Waste Management*, 30, 14.
- Lal, K. and Mhohnen, P. (2009). *Innovation Policies and International Trade Rules: The Textiles and Clothing Industry in Developing Countries*. Basingstoke: Palgrave MacMillan.
- LEAT (2010). Lawyer’s Environmental Action Team. Major Environmental Problems in Tanzania [online]. Available from

<http://www.lead.or.tz/publications/decentralization/1.3.env.problems.php> [Accessed 23/05/2012].

Mahwera, D. (2009). Utilisation of Textile Wastes for Producing Fashion in Tanzania. M.Phil Thesis, University of Manchester.

Mbuligwe, S., Kassenga, G., Kaseva, M. & Chaggu, E. (2002). Potential and Constraints of Composting Domestic Solid Waste in Developing Countries: Findings from a Pilot Study in Dar es Salaam, Tanzania. *Resources, Conservation and Recycling*, 36, 45 – 49.

Medina, M. (2005). Waste Picker Co-operatives in Developing Countries. Paper prepared for WIEGO/Cornell/SEWA Conference on Membership-Based Organizations of the Poor, Ahmedabad, India, January 2005

Mkenda, B. (2005). The Impact of Globalisation on Tanzania's Labour Market: Evidence from the Manufacturing Sector. A Paper Prepared for a Policy Dialogue for Accelerating Growth and Poverty Reduction in Tanzania. Paper presented at the ESRF.

Michaud, J-C., Farrant, L., Jan, O., Kjaer, B., and Bakas, I. (2010). Environmental Benefits of Recycling – 2010 Update [online]. Available from:  
<http://www.wrap.org.uk/content/environmental-benefits-recycling> [Accessed 25/05/2012]

Mistra (2010). Future Fashion Research Programme: Background Paper. 2010-09-03.

Morley, N., Slater, S., Russell, S., Tipper, M. and Ward, G. (2006). Recycling of Low Grade Textile Waste. WRT152. Technical Report for Defra [online]. Available from:  
<http://www.oakdenehollins.co.uk/textiles-clothing.php> [Accessed 22/05/2012].

Morley, N., McGill, I. and Bartlett, C. (2009). Maximising Reuse and Recycling of UK Clothing and Textiles EV0421. Technical Report for Defra [online]. Available from:  
<http://www.oakdenehollins.co.uk/textiles-clothing.php> [Accessed 22/05/2012].

Mulligan, D. (2012). Personal Interview. March 2012: Edward Clay & Son Ltd, Ossett.

Needham-Brinley, L. (2012). Personal Interview. April 2012: Oxfam Waste Saver: Huddersfield.

Norris, L. (2005). The Secrets of Recycling in India. In Kuchler, S. & Miller, D. (Eds), *Clothing as Material Culture*. Oxford: Berg.

Norris, L. (2010). Recycling Indian Clothing: Global Contexts of Reuse and Value. Bloomington: Indiana University Press.

Norris, L. (2012). Recycling Imported Secondhand Textiles in the Shoddy Plants of Panipat, India: An Overview of the Industry, Its Local Impact and Implications for the UK Trade.

Nunes, B. and Bennett, D. (2010). Green Operations Initiatives in the Automotive Industry: An Environmental Reports Analysis and Benchmarking Study", *Benchmarking: An International Journal*, 17 (3), 396 – 420.

Ouchi, A., Toida, T., Kumaresan, S., Ando, W. & Kato, J. (2010). A New Methodology to Recycle Polyester from Fabric Blends with Cellulose. *Cellulose* 17, 215 – 222.

Palfreman, J. (2010). Waste Management and Recycling in Dar-es-Salaam, Tanzania. Goldsmiths University of London.

Palm, D. (2011). Improved Waste Management of Textiles B1976. A Report for the Swedish Environmental Research Institute.

Rivoli, P. Travels of A T-Shirt in the Global Economy (Second Edition). Hoboken: John Wiley and Sons, Inc.

Ruta, C. (2012). Second-Hand Clothing for Developing Countries – A Blessing or a Curse? [online]. Available from: < <http://www.dw.de/dw/article/0,,15856826,00.html> > [Accessed 24/05/2012].

Skat Foundation (2003). Solid Waste Collection that Benefits the Urban Poor. Dar es Salaam. Skat Foundation.

Tatkis (2007). Coco Fiber [online]. Available from: <http://cocosproducts.com/cocfiber.html> [Accessed 23/05/2012]

Textiles4Textiles (2012). Textiles4Textiles [online]. Available from: <http://www.textiles4textiles.eu/> [Accessed 25/05/2012].

Uiterkamp, B., Schoot, A. and Ho, P. (2011). Sustainable Recycling Model: A Comparative Analysis between India and Tanzania. *Resources Conservation and Recycling*, 55 (3), 344 – 355.

UNIDO (United Nations Industrial Development Organisation) (2012). Recycling Process Centre Project – Dar es Salaam [online]. Available from: <http://www.unido.org/index.php?id=6463> [Accessed 22/05/2012].

Unifi (2012). Repreve. For the Planet [online]. Available from: <http://www.repreve.com/>. [Accessed 25/05/2012].

Zamani, B. (2011). Carbon Footprint and Energy Use of Textile Recycling Techniques. Case Study: Sweden. Master of Science Thesis, Chalmers University of Technology, Goteburg, Sweden.

## **City shrinkage in Japan: phenomena, managing and reviving policy strategies**

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*Abstract: City shrinkage is gradually becoming a common phenomenon wide around the world. In Japan, over 90% of the municipalities are losing their population. How to deal with the shrinking issue and problems caused by its chain effects still remains a challenge for researchers from various disciplines. In the paper, the shrinking phenomena in Japan are well analysed by case study from the perspective of residential choice and land use conversion by land use data and social and cultural statistics. Aimed at maintaining life quality of residents and preserving natural environment and ecosystem, policy strategies responding to shrinking problems are proposed*

*Keywords: City shrinkage, Census, GIS, Order logit model, Planning policy*

### **1. Introduction**

Cities in developed countries throughout the world are facing population declines at an unprecedented scale. Over the last fifty years, 370 cities throughout the world with populations over 100,000 have shrunk at least 10% (Oswalt, P and T. Rieniets. 2007). Wide swaths of the U.S., Canada, Europe, and Japan are projecting double-digit decline in population in the coming decades (Justin et al, 2009).

According to the census data in Japan from 2000 to 2005, over 93% of 2217 municipalities are losing their population. According to the population projection of NIPSSR, Japan will continue to decline at a rate of approximately 800,000 of population per year between 2010 and 2050 (NIPSSR,1997).

Depopulation due to out-migration and/or lower fertility and residential preferences change leads to a shift of inhabitants from city core to the suburbs, which will give rise to city sprawling in the city fringe as well as lower density of population near city core area (Sigrun et.al., 2006). Both population loss in the city core and sprawling peripheries will cause a dispersed city structure, which in the sense of environment, large brownfields and land wastage will be left in the city core, but new expansion in the suburb will destroy natural environment and ecosystem, on the other hand, from the perspective of inhabitants, due to the over low residential density, negative influence on quality of life may be generated by difficulties to access to infrastructures, lose the sense of community and social segregation.

## 2. Literature review

### 2.1 Studies of city shrinkage

In order to take respond to world-wide phenomenon of city shrinkage, in recent years, city planners and researchers from various disciplines through out of the world have highly concerned themselves with how cities shrink (Justin et.al, 2009).

Most studies about city shrinkage are concentrated in Europe and North America. In Europe, the word “shrinking cities” (or “schrumpfende Städte” in German) is originated to describe the decline processes that many post-socialist East-German and East-European cities are experiencing (Wiechmann 2009). The breakdown of ‘Socialist world’ has result in de-industrialisation of the urban economy additionally with far-reaching social cultural consequences. Some case studies concerning with Post-Socialist shrinkage and ranging from various aspects are made in Europe. Marco Bontje (2004) analyzed the causes and consequences of city shrinkage in Leipzig and confirmed the fact that the declination of economy and demography in Leipzig has taken on critical dimensions since 1989 and the ‘shock therapy’ that followed the end of socialist regime in former German Democratic Republic, and in Germany, similar studies also made in Eisenhutenstadt (Lienhard el.al, 2004), Dresden (Wiechmann T. 2009) and Halle (Dieter el.al 2010). Besides, Melinda Dinca and Bogdan Nadolu (2010) analyzed the suburbanization and declination pattern of the shrinkage in Timisoara. Kagurs Kristaps (2011) investigated the state of awareness of urban shrinkage in Liepaja in the planning process. Case studies in Europe revealed a similar shrinking pattern, that is the collapse of local economy during the ‘post-socialist transformation’ (Marco Bontjie 2004; Lienhard el.al, 2004) has led to the high job-related out-migration rate, and cities shifted from prosperous industry or economic center to constant declining area in a relatively short time with shrinking population (Wiechmann T. 2009; Dieter el.al 2010; Kagurs Kristaps 2011) and spatially dispersed city structure (Lienhard el.al, 2004; Ellen el. Al 2007; Melinda Dinca and Bogdan Nadolu 2010).

Slightly different from the post-socialist type of city shrinkage in Europe, ‘Shrinking cities’ in North America mainly refers to Post-Industrialization cities (Pallagst K. 2009). Case studies of the ‘Post-Industrialization’ city shrinkage are concentrated on the ‘Rust Belt’ of U.S. like Pittsburgh (Pallagst K. 2009), Detroit (Brent D. Ryan 2008; Robert A. 2009), Youngstown (Laura Schatz 2008; Pallagst K. 2009), etc. These cases are cities highly depended on single industry, and with the declination of supporting industry, high unemployment rate has led to high out-migration rate and caused the shrinkage of the cities (Robert A, 2009).

Besides cities in Europe and USA, since the mid-2000s Japan has been losing population and aging faster than any OECD country, Japanese cities are drawing the attention of not only some local researchers but also international study groups that consider shrinking cities a global phenomenon (Oswalt et al. 2006; Cunningham-Sabot and Fol 2009). Different from the ‘Post-socialist’ type shrinkage in Europe or ‘Post-industrialization’ shrinkage in U.S., except for very few mining areas, Japan’s city shrinkage starts from small cities at the rural peripheries like cities in Hokkaido (Winfried Fliichter, 2010). In Keiro Hattori (2010)’s research, census data comparison has showed that during 2000~2005, all the municipalities with population less than 50,000 have been shrinking, and the municipalities are smaller, the speeds of shrinking are faster. With economic stagnation in Japanese shrinking cities, but unlike dramatic process of de-industrialization in shrinking cities in Europe or U.S., city shrinkage is highly associated with low birth rate and city attractiveness competition among Japanese cities, especially the competition with the mega city Tokyo (Sophie Buhnik 2011).

However, until now, the empirical study in Japan is still very scarce comparing to the studies in Europe and U.S. City shrinkage of Japan not only as very critical problem in

Japan but also as a global issue needs to be well analyzed and deep researched.

Policies to manage shrinking cities

## **2.2 Policies to manage and revive shrinking cities**

As pioneers of exploring policy strategies to deal with the shrinking issues, there are some important experiences can be learnt from the Europe and Northern America.

In recent decades, the conception of 'compact city' has been regarded as the sustainable direction for European cities (Jochem F.M. and Van Der Waals, 2000), which contains the points like increasing overall accessibility, re-use of infrastructure and previously developed land, rejuvenation of existing urban area in order to building a dynamic city core with higher density, at the same time preserve of green land and open space (Jenks et al., 1996; Williams et al., 2000).

Northern America is pushing the concept of 'New Urbanism' (Katz, 1994) as a way of combating suburbanization and shrinkage, which makes efforts to increase walkability and accessibility, mix land use with discernible center and edge, and improve city density. Currently, there are over 4,000 New Urbanism projects planned or under construction in the United States alone, half of which are redevelopments in historic urban centers (NewUrbanism.org).

The two concepts that are now widely used in Europe and Northern America share the common points that are to intensify accessibility, improve density and redevelop existing city area instead of new expanding.

Building a compact city helps to increase the 'magnetic' of the city (Rollin Stanley, 2010). There are some successful cases that have revitalized from shrinkage by re-concentrate the cities. One example is Dresden in East Germany which lost 60,000 of 500,000 residents during 1989 to 1999 because of high out-migration rate. In 2000, the government changed its policy from growth-oriented policy to urban restructure, and started to build compact 'European city' with an attractive urban center and reduced land consumption. From 2002, the city has started re-urbanization, and unexpectedly there is a growth of 25,000 residents within last 7 years which is first time to grow after 1970s (Wiechmann T., 2010). The similar success has been achieved in Rotterdam, which had lost about a quarter of its population between 1960s and 1980s, but since the implementation of the compact city policy, after reconstruction of its central area and re-imaging of its cultural identity on an international level, there has been an annual rise in population (McCarthy, J., 1998). Focusing towards stabilizing the current population and adjusting the housing stock to the population size, in Leipzig, abandoned houses or even communities have turned into more attractive, greener environment and planners stresses the restructuring of vacant and derelict industrial area within the existing city perimeters. Compared with most other East German cities, Leipzig is doing well in economic and population maintenance (Bonjie Marco, 2004; Alan Mace et al 2004).

Typical policies for managing shrinking cities are 'Raze and Rebuild' and 'Right Sizing' in North America. In places like Jennings and Richfield, cities have cleared old regional shopping centers and dilapidated homes, drive-in retail and run-down car dealerships for re-malling projects anchored by big-box retailers. Hefty state, county, and city subsidies help form public-private partnerships for redevelopment (Ivonne Audirac 2009). Another example is Youngstown, between Cleveland and Pittsburgh, is a classic Rust Belt town. It and similar cities struggled in vain to revive their declining steel industry and reverse population loss. Copycat "build and they will come" strategies -- infinitely expanse infrastructure to recovery -- sank without trace. Instead of infinite growing oriented policy, the attention of policy makers has turned to how to maintain the life quality of residents. With the perspective that accept Youngstown will be a smaller city, but smaller can also be better, policies are made to downsize the city with retrieving land in the suburb by land bank, turn vacant places into parks and green land, and improve the



service and infrastructure at key parts (Pallagst K. 2009). In Buffalo, green infrastructure initiatives, in combination with land banking and community-driven planning are together used to form a right-sizing city (Joseph Schilling, 2009). Local government in Flint has decided to demolish entire blocks and even whole neighborhoods instead of waiting for houses to become vacant and abandoned in order to condense the population into few viable areas (David Streitfeld, 2009).

### 3. Methodology

#### 3.1 Statistical analysis

Use census data and population survey in different years to trace the changes in population of Katsuura-shi. And population changes and household changes are also compared among 48 districts of Katsuura-shi. Use the households demand survey data to analyze the intention of migration choice, which can indicate the trend of households' migration choice. Also the descriptive analysis of satisfaction on different aspects of residential environment is analyzed. Use the overlay analysis in Arcgis to detect the construction change in 1997, 2003, and 2009. The changes in area of residential land vacancy ratio of dwellings are also analyzed by social survey data.

#### 3.2 Interview with local government

Contact officers in local government to discuss the main problems, current policy strategies, and future plan in the shrinking city.

#### 3.3 Ordered logit model for residential satisfaction analysis

Ordered logit model is used to estimate relationships between an ordinal dependent variable and a set of independent variable. An ordinal variable that is categorical and ordered.

In ordered logit, and underlying score is estimated as a linear function of independent variables and a set of cut points. The probability of observing outcome  $i$  corresponds to the probability that the estimated linear function, plus random error, is within the range of cut points estimated for the outcome (Long and Freese 2006; Cameron and Trivedi 2005):

$$\begin{aligned} \Pr(\text{outcome}_j = i) &= \Pr(k_{i-1} < \beta_1 x_{1j} + \beta_2 x_{2j} + \dots + \beta_k x_{kj} + \mu_j \leq k_i) \\ &= \Pr(k_{i-1} < \beta x_j + \mu_j \leq k_i) \\ &= \frac{1}{1 + \exp(-k_i + \beta x_j)} - \frac{1}{1 + \exp(-k_{i-1} + \beta x_j)} \end{aligned} \quad (1)$$

Where  $\mu_j$  is assumed to be logistically distributed in ordered logit. In either case, we estimated the coefficients  $\beta_1, \beta_2, \dots, \beta_k$  together with the cut points  $k_1, k_2, \dots, k_{k-1}$ , where  $k$  is the number of possible outcomes.  $k_0$  is taken as  $-\infty$ , and  $k_k$  is taken as  $+\infty$ .

In the research, an ordered logit analysis is conducted to survey the factors that influence the satisfaction level of local residents about the residential environment. The dependent variable is overall residential satisfaction level (very unsatisfied:1; unsatisfied:2; satisfied:3; very satisfied:4). The independent variables include household features (kids, old members, persons, etc.), satisfaction level for personal relationships (relatives, neighbour), and satisfaction level for regional factors (pollution, infrastructure, etc.). Regression samples are 11441 households in Chiba Prefecture from households demanding survey in 2005.

After the ordered logit regression, marginal effects are analyzed for each overall residential satisfaction categorizes. Marginal effects can provide a good approximation to the amount of change in  $Y$  that will be produced by 1 unit change in  $x_k$ . Equation (2)

shows the how  $\Pr(Y=1)$  changes as the variables changes from 0 to 1, holding all other variables at their means.

$$\text{Marginal Effect } x_k = \Pr(Y = 1|x, x_k = 1) - \Pr(Y = 1|x, x_k = 0) \quad (2)$$

## 4. Case study: Katsuura city

### 4.1 Description of study area: Katsuura city

Katsuura city (勝浦市, Katsuura-shi) is a city located in the southern part of Chiba Prefecture, in Japan. Katsuura city is famous for Katsuura fishing port, which features one of the top three largest morning markets in Japan. According to the most recent statistical survey of planning department of Katsuura city local government, in 2011, the city has a population of 20,388 the density of 216 persons per  $\text{km}^2$ , and the households of 9,105.

Katsuura city contains 48 districts, among which relatively prosperous places are Katsuura district and Okitsu district. In Katsuura district, in 2011, the number of population is 10573, and the number of households is 5115. And in Okitsu district, in 2011, the number of population is 4315, and the number of total households is 1835. Figure 1 shows the location of Katsuura city in Chiba Prefecture and 48 districts in Katsuura city.

Katsuura city is one of 93% municipalities in Japan losing their population. Katsuura city start to constantly lose population since 1990s. From 1990 to 2010, the population of Katsuura has dropped from 25334 to 20,797. As Table 1, the average change rate every five year in Katsuura city is -4.5%. 66% of the municipalities have shared the similar depopulation rate. Katsuura city is a representative case study area to study the shrinking city issue.

Figure 2 show the images of the relative prosperous parts of Katsuura city, Katsuura district and Okitsu district. The only subway station in Katsuura, supposed to be the place many people passing by, is quite empty. A lot of restaurants and shops on the shopping street are closed even abandoned. It is hard to see people walking on the street comparing to Tokyo, and along the street there are a lot of vacant houses.

Year	1990	1995	2000	2005	2010	Average
Population	25334	24328	23235	22198	20797	
Change		-1006	-1093	-1037	-1401	-1134.25
Change rate		-0.040	-0.045	-0.045	-0.063	-0.045

Table 1 population change in Katsuura city

Source: census data

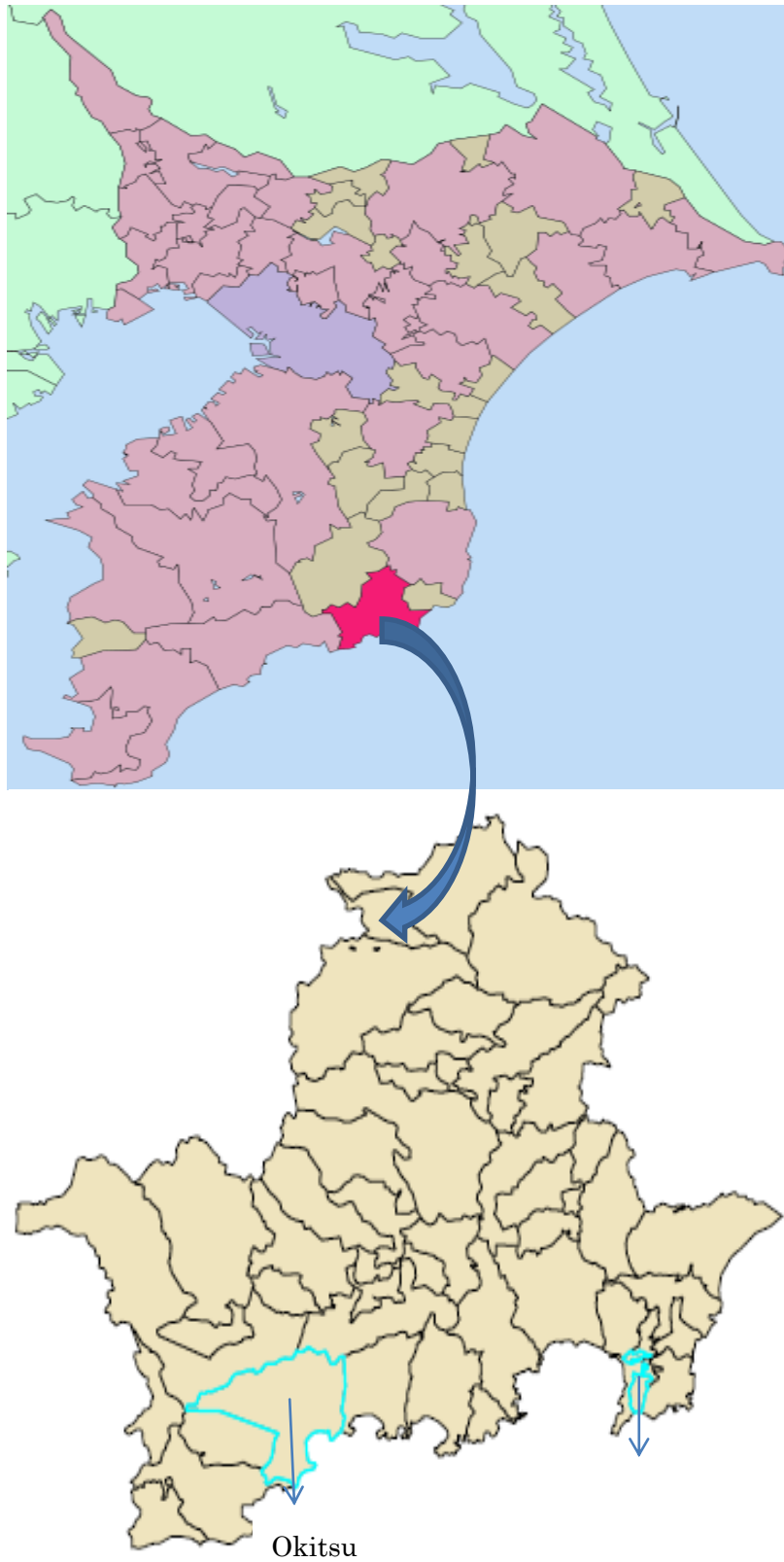


Figure1 Location of Katsuura city in Chiba Prefecture and 48 districts in Katsuura city



Figure 2 Empty station, vacant houses, closed shops and restaurants in Katsuura district and Okitsu district, Katsuura city

## 4.2 Population and land use change

The census analysis (Figure 3) shows that the population in Katsuura-shi has been declining since 1980s, and until it has lost about 20% of population during the period from 1980 to 2010.

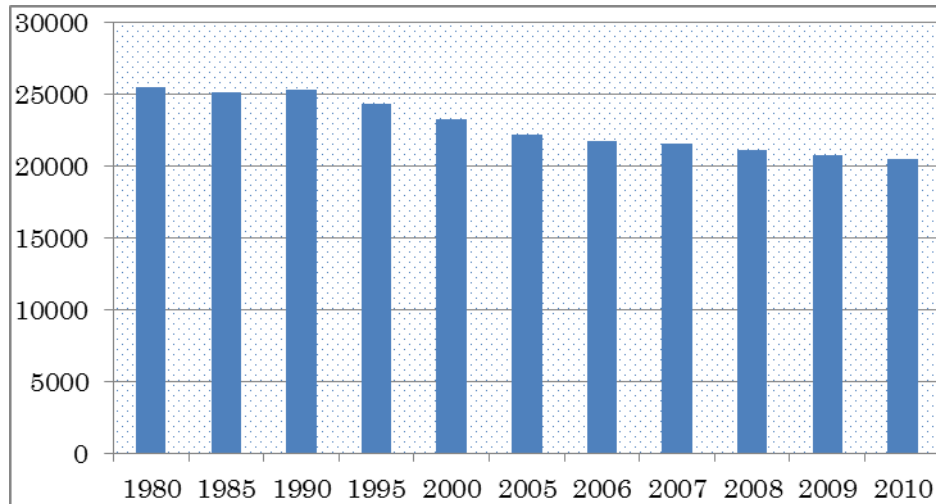


Figure 3: Population change in Katsuura-shi (unit:person)

Source: census data and local residence survey of Katsuura

Figure 4 and Figure 5 shows the population and household change rate between 2000 and 2005. As Figure 4 shows although few districts are still growing, most districts of the city are losing their population, and the two places which used to be relatively prosperous in Katsuura city (Okitsu and Katsuura) which are marked by black circles, are losing population at relatively higher rate than other districts. The number of households (Figure 5) has not been declining as fast as rate of population, even though Okitsu and Katsuura are still obviously losing households at higher rate than average in Katsuura city.

Households demand survey made the inquiry about the intention of residential choice, 112 households in Katsuura-shi have responded to the questionnaire survey. According the responses of 112 surveyed households, Figure 6 shows about 45% of surveyed residents would like to move to the suburb area in the future, but only 23% of respondents showed the intention to move to the near city core area. The preference of moving to the suburb is very obvious in the survey, which will lead to even less population at near city core area in Katsuura-shi.

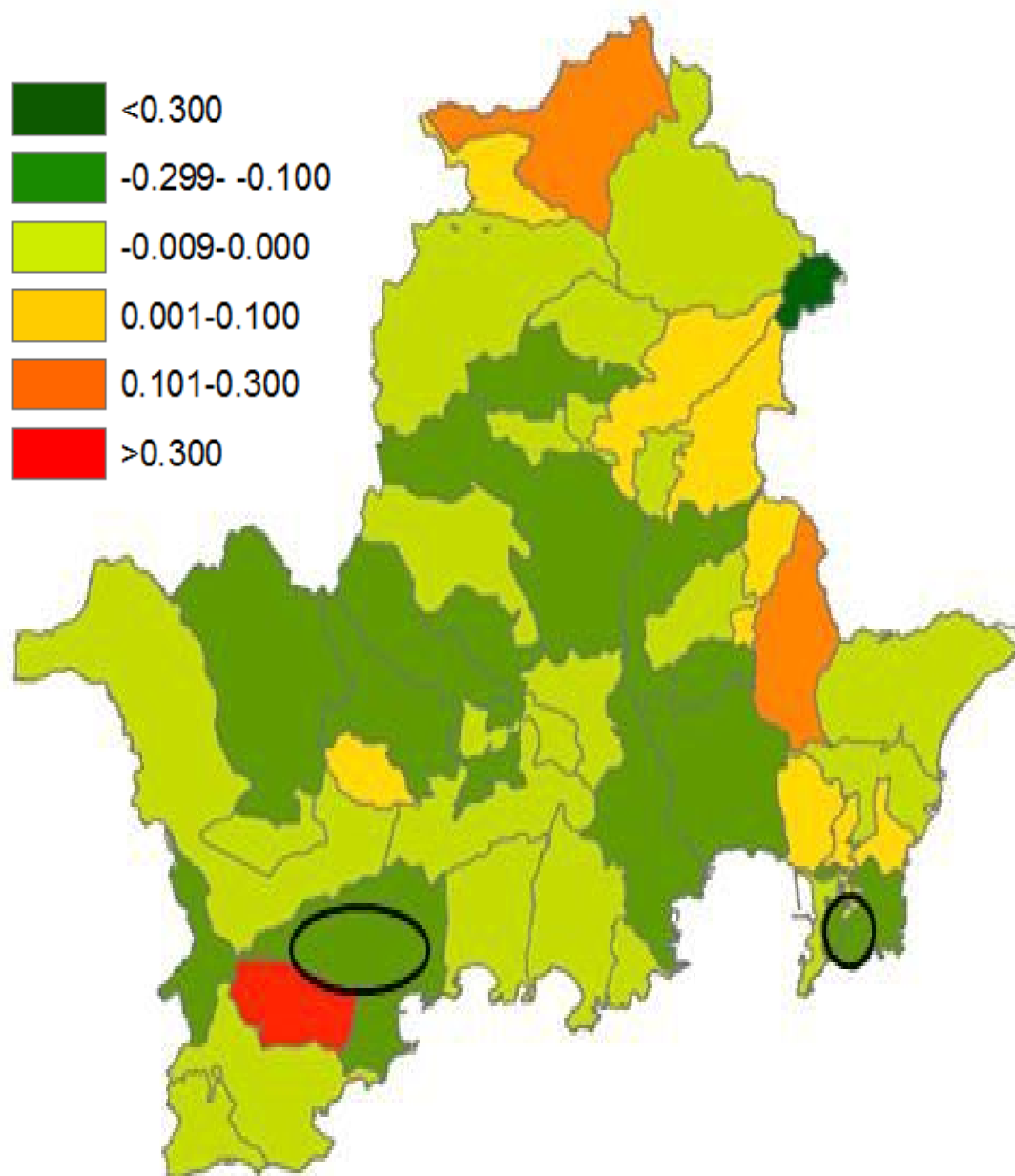


Figure 4: Population change during 2000~2005 in 48 districts of Katsuura-shi (unit:%) Source: Census data



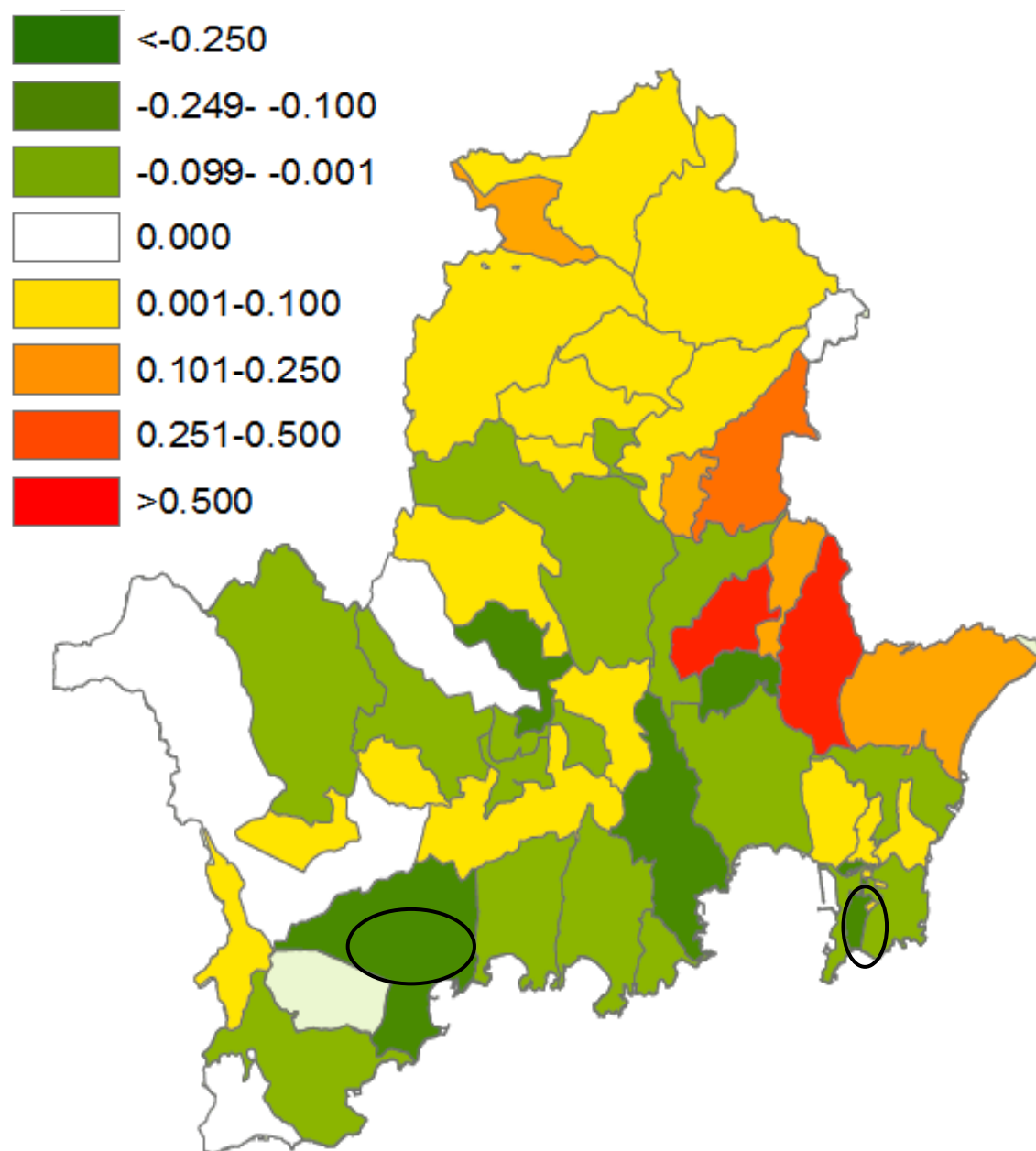


Figure 5: Households change during 2000~2005 in 48 districts of Katsuura-shi (unit :%) Source: Census data

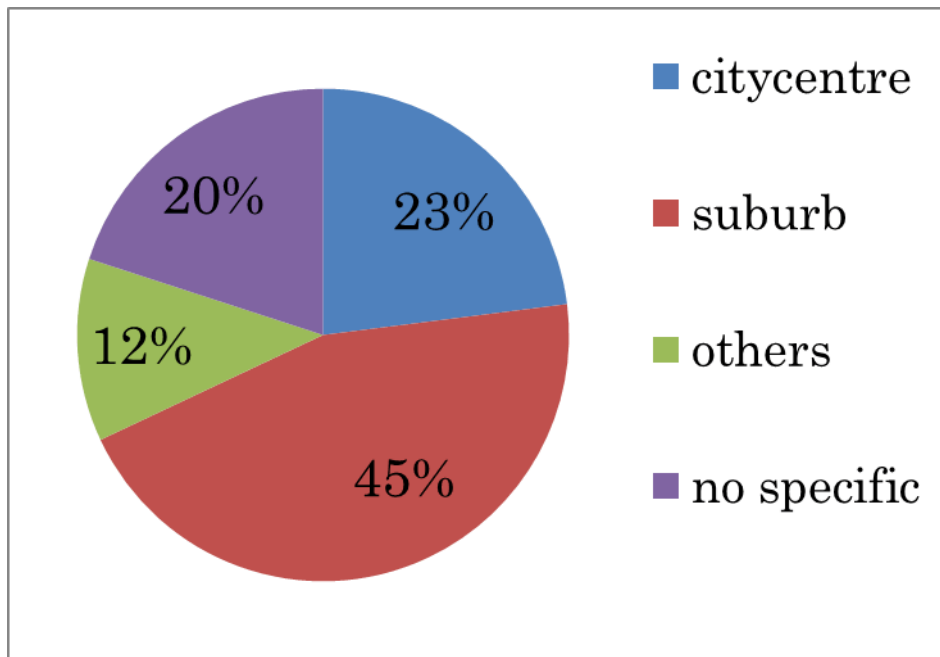


Figure 6: Intention of residential migration (unit:%)

Source: households demand survey in 2005

According to the land use overlay analysis during the period 1997~2003 (Figure 7), there are many new constructions built in the suburb area, and the city structure has a city sprawling pattern.

During the period 2003~2009 (Figure 8), there is still few new construction built, but many constructions have been dismantled especially the constructions near the city center area. After city sprawling during 1997 to 2003 and construction demolition during 2003 to 2009, the structure of the city has been more dispersed than before.

The population is constantly declining, but the residential area is still expanding (Figure 9), which causes even lower population density. Lots of new dwellings have been constructed, until 2003 the vacant rate of dwellings has jumped to 30.5% from 23.4% in 1993(Table 2).



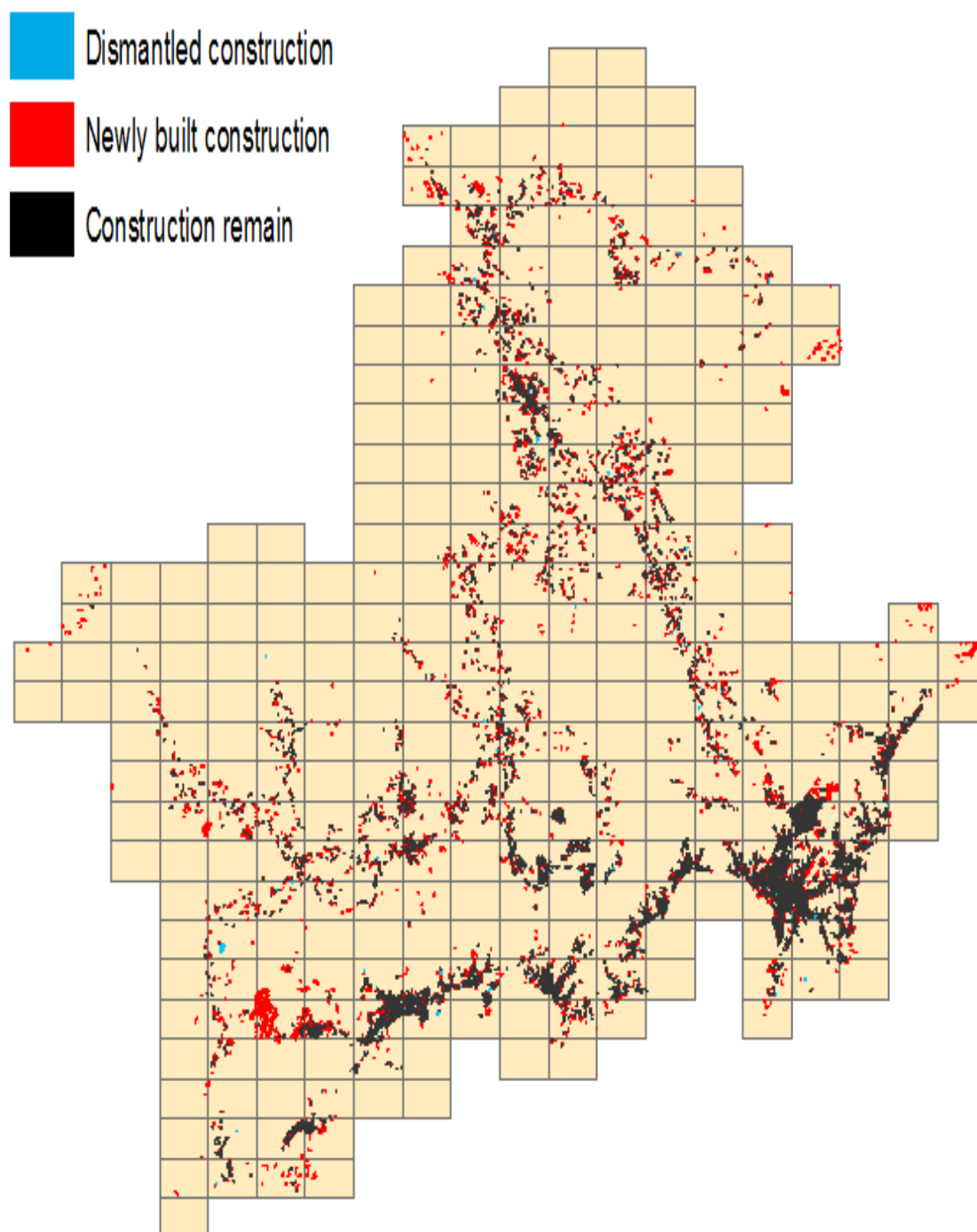


Figure 7: construction change analysis in Katsuura-shi during 1997~2003 Source: Zmap town GIS data

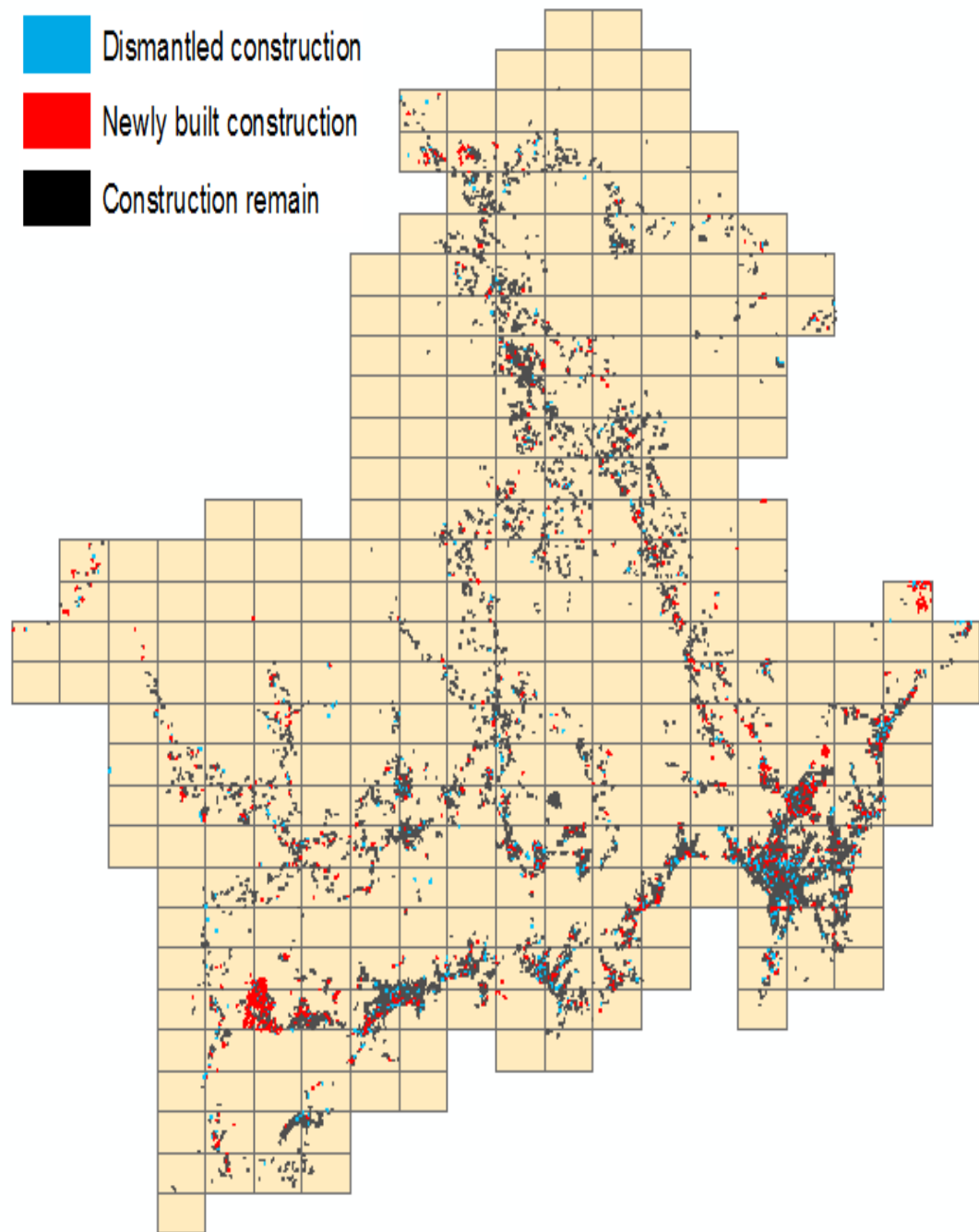


Figure 8: construction change analysis in Katsuura-shi during 2003~2009  
Source: Zmap town GIS data

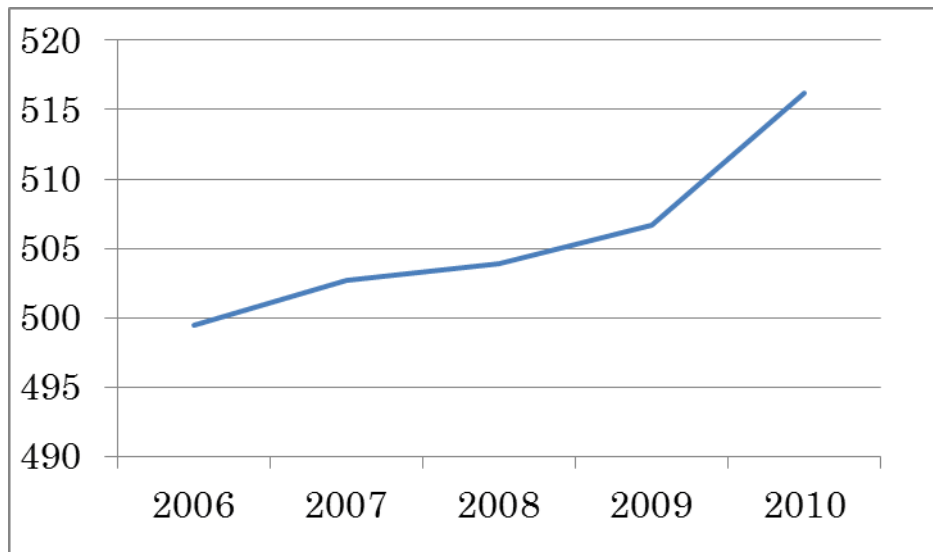


Figure 9: Change in area of residential land in Katsuura-shi (unit:ha)  
Source: tax department of Katsuura local government

Year	Total dwellings	vacancy	(Vacancy/total) ratio
1993	11920	2790	0.234
2003	12540	3830	0.305

Table 2: Total dwellings and vacancy in Katsuura-shi

Source: statistics of residence and land in 1993 and 2003

According to the past and current situation analysis by social and land use statistics, Katsuura city is a typical shrinking city. City dispersion with over low population density and large land wastage is not a sustainable way of development. As explained in the background, on one hand, new expansion in suburb occupying arable land and forest would destroy natural environment and ecosystem, at the same time leaving large brownfield, vacant houses and under-utilized infrastructure in the inner city area; on the other hand, due to over low density of population, the life quality of residents will be negatively influenced by having difficulties to get access to infrastructure and service, gradually losing the sense of community and possibly causing social segregation. The city should be restructured. The main goals should focus on maintaining the life quality of residents as well as preserving the environment

#### 4.3 interview with local government

In order to have a further understanding about the main causes of the current situation, on-going policies, and future plan in Katsuura city. A interview was conducted with Officer Toshiyuki SEKI in the Department of Planning of Katsuura City, and Officer Yoshiyuki FUJIIHARA in the Department of Urban Construction of Katsuura City on May 1st at Katsuura city hall.

According to the interview, one of the main reasons is the declination in job opportunity. The main industries in Katsuura city are agriculture, fishing and tourism. Since 1950s, Japanese government has promoted mechanized production, as a result, there is much less demand for labor in agriculture and fishing than before. And the decline of the production of the fish and shell makes the employment demand in fishing industry even smaller. Moreover, the once profitable market in sea resort has shrunk due to the appreciation of yen, and customers who used to choose spend summer at sea resort in

Katsuura city now choose travelling abroad. Due to the shrinkage in job market, many people moved out to other cities especially Tokyo for job opportunity. In addition, young generation has become more educated than before. More highly educated people have more choices for work, thus young people who have received education in big cities tend not to go back in Katsuura city. Another important reason is the change of value system. Young generation has not valued the house inheritance as much as before. Also late marriage and low birth rate have become a national phenomenon in Japan.

The fast population declination in Katsuura district and Okitsu district is mainly due to the shrinkage in tourism market. The districts were once the popular sea resorts. Due to the appreciation of yen, customers who used to choose spending summer at sea resort in Katsuura city now choose travelling abroad. As the decline in costumers of sea resorts, the inns and restaurants run by local households have to be closed. That is why the part of local people who made living depending on the natural landscape has to move out the Katsuura district and Okitsu district. Also, because 'Nippon Yakin Kogyo' has closed, workers in the company has become unemployed, and a big park called 'Namegawa Island' have closed too, which make the Okitsu and Katsuura districts much less attractive for residents. After the earthquake in 3.11, concerning the threat of tsunami, local government would like to encourage residents who lived near coastline like Okitsu and Katsuura districts to move to areas with higher elevation.

Although the population is constantly decline, the residential area is still expanding. Except for the fact the shifting of preference to moving to suburb, there is a tendency that household type is gradually shifting from big family to nuclear family. The vacancy rate is very high in the city core area.

High vacancy and low density will cause many negative influences on residential satisfaction. One of the most obvious negative impacts is to cause low efficiency of infrastructures. Due to population decline, the lines and frequencies of buses and JR also decreased which brings inconvenience in daily life of residents especially for the aged residents who cannot use their own cars. Also, many shops have closed due to the depopulation. Due to the budget limitation and low efficiency, it is very difficult to improve the infrastructure, for example, it is difficult to improve the narrow road or construct new culture, art, sports facilities in Katsuura city.

In order to maintain the population, International Budo University have been built in Katsuura, but students intend not to stay in Katsuura city after graduation, thus the strategy has little effect for maintaining the population. Besides the International Budo University, double track of JR Line has introduced to promote the tourism, but costumers usually will not stay overnight, thus there is not much improvement on tourism or population. Moreover, the fishing port has been improved for adscititious fishing boat to load the bonito, by improving the fishing industry to improve the population, but until now, the effect is limited.

In the future, first of all, local government tries to revive fishing industry and tourism to revive Katsuura city. 3,000,000,000 yen subsidized partly by national government will be used to build improve the fishing port in 2018. And the interchange of high way connecting to Tokyo will be constructed in March, 2013, and until then the traveling from Tokyo to Katsuura will just cost one hour. The construction of highway makes the commuting between Tokyo and Katsuura much easier, based on the convenient transportation, local government want to promote a new life style to encourage people who are working in Tokyo in workdays spend weekends in Katsuura city to enjoy the beautiful landscape. Besides, various events are held to attract more visiting population like bonito festival in June and "BIG HINAMATSURI" festival (big doll festival) from February to March.

Local government plans to change Master Plan in 2012 or 2013. They incline to plan the

city on the base of inclination of community. The budget is main difficulty, because after the bubble economy, the tax rate has decreased, and there is no city planning tax charged in Katsuura city.

#### **4.4 Residential satisfaction of households**

In order to make policy based on the improving the residential satisfaction, the survey about the residential satisfaction is quite important.

Table 3 shows the percentages of satisfaction levels for various items from the 112 surveyed households from households demanding survey in 2005. As Table 3, for the items including disaster prevention, road safety, infrastructure, park, there are more households have chosen unsatisfied and very unsatisfied than satisfied and very satisfied. The fact is indicating that in Katsuura city, households are unsatisfied with the disaster prevention, road safety, accessibility to infrastructures, and accessibility to parks. In order to improve the residential satisfaction in Katsuura, the four aspects should be taken more attention in further analysis.

In order to evaluate what factors significantly influence the households' residential satisfaction. The ordered logit regression is used for residential analysis. The samples for regression are from households demanding survey in 2005. 11441 residents' responses in Chiba prefecture are used as samples. The dependent variable is the overall satisfaction level about the residential environment which is divided into 4 categories (1: very unsatisfied 2: unsatisfied 3: satisfied 4: very satisfied). The independent variables in the analysis including household features like kids, number of family member etc., and regional factors like density, satisfaction about road safety, accessibility to infrastructures etc. Table 4 shows the data description of the regression samples.

Table 5 shows the result of regression. Factors marked by '\*\*\*' are highly significant to satisfaction level. Among all regional factors, Density is one of the most significant factors in the regression, which indicates that population density is very important to achieve a higher level of residential satisfaction. Factors like 'Disaster prevention', 'Road safety' and 'Crime' indicate that safety is fundamental element to evaluate the residential environment. Factors like 'Natural Environment' and 'Pollution' indicate good natural environment with less pollution and higher density is highly associated with the life quality of residents. Also improving accessibility to infrastructures is very important to improve possibility to achieve higher level of overall satisfaction.

	Very satisfied	satisfied	unsatisfied	Very unsatisfied
Overall satisfaction	0.11	0.55	0.30	0.04
Disaster prevention	0.08	0.35	0.42	0.15
Slope and shape of land	0.04	0.49	0.46	0.01
Road safety	0.11	0.25	0.53	0.12
Crime	0.09	0.42	0.46	0.04
Pollution	0.29	0.42	0.21	0.08
Work	0.18	0.39	0.41	0.02
Infrastructure	0.13	0.29	0.39	0.20
Park	0.08	0.38	0.28	0.26
Natural environment	0.12	0.54	0.26	0.08
Sunshine ventilation	0.21	0.46	0.29	0.04
Townscape	0.09	0.48	0.43	0.00
Relative	0.13	0.71	0.15	0.00
Neighbor	0.19	0.53	0.28	0.01
Welfare	0.09	0.49	0.41	0.03

Table 3 satisfaction percentage in Katsuura city

Dependent Variable	Description	min	max	mean	Std. Dev.
Satisfaction	Overall residential satisfaction	1	4	2.737	0.777
Independent Variables	Description	min	max	mean	Std. Dev.
Kids	Have kids or not	0	1	0.728	0.445
Old	Have people over 60 or not	0	1	0.095	0.292
Oldonly	Only people over 60 in the household or not	0	1	0.090	0.287
Persons	Number of household members	1	10	3.677	1.568
Relative	Satisfaction level of the residential distances to relatives	1	4	2.713	0.767
Neighbor	Satisfaction level of relationship between neighbors	1	4	2.824	0.654
Work	Satisfaction level of commuting convenience	1	4	2.618	0.881
Density	With dense population or not	0	1	0.542	0.498
Disaster prevention	Satisfaction level with the facilities for disasters	1	4	2.602	0.751
Road safety	Satisfaction level of road safety	1	4	2.415	0.810
Crime	Satisfaction level of prevention for crime	1	4	2.457	0.700
Pollution	Satisfaction level with the prevention for pollution	1	4	2.704	0.759
Sunshine ventilation	Satisfaction level with the sunshine and ventilation	1	4	2.880	0.816
Natural environment	Satisfaction level with the natural environment	1	4	2.834	0.761
Townscape	Satisfaction level with the overall townscape	1	4	2.752	0.729
Park	Satisfaction level with the distances to parks or playground	1	4	2.499	0.831
Infrastructure	Satisfaction level with the accessibility to shopping malls, hospitals, cultural facilities, etc.	1	4	2.572	0.852
Slope and shape of land	Satisfaction level with the slope and shape of the construction land	1	4	2.376	0.729
Observation: 11441					

Table 4 Samples for ordered logit regression  
Source: households demanding survey in 2005

Variable	Coef.	Std.Err.	z	P
Kids	-0.1252**	0.0553	-2.26	0.012
Old	-0.1487	0.0934	-1.59	0.056
Oldonly	0.1111	0.0916	1.21	0.113
Persons	0.0379***	0.0146	2.58	0.005
Relative	-0.0691***	0.0278	-2.48	0.007
Neighbor	0.4254***	0.0338	12.56	0.000
Work	0.1748***	0.0284	6.15	0.000
Density	0.1265***	0.0445	2.84	0.003
Disaster prevention	0.2966***	0.0310	9.55	0.000
Road safety	0.4171***	0.0306	13.59	0.000
Crime	0.1116***	0.0348	3.2	0.001
Pollution	0.3971***	0.0298	13.31	0.000
Sunshine ventilation	0.0296	0.0316	0.94	0.175
Natural environment	0.1092***	0.0278	3.92	0.000
Townscape	0.4943***	0.0344	14.37	0.000
Park	0.2494***	0.0305	8.17	0.000
Infrastructure	0.2656***	0.0308	8.61	0.000
Slope and shape of land	0.0766***	0.0322	2.38	0.009
Cut1	4.3563	0.1410		
Cut2	7.1362	0.1485		
Cut3	10.2773	0.1651		

\*\*\* p<0.01, \*\* p<0.05, \* p<0.1  
Observations: 11,441  
Loglikelihood=-10843.842  
LR chi2(18)=4706.05  
Prob > chi2= 0.0000  
Pseudo R2= 0.1783

Table 5 ordered logit analysis results of satisfaction of residents

## 5. Conclusion

Katsuura city is a typical shrinking area. A dispersed city with over low population density and large land wastage is a sustainable way of development. Besides improving the fishing industry and tourism, aimed at maintaining the life quality of residents as well as preserving the environment, try to concentrate population in a proper sized city area in order to achieve a higher density and prevent from city sprawling by Limit new expansion on the arable land or undeveloped land, at the same time redevelop the existing city are by improving infrastructure and serves to attract residents move back to the inner city area will be a possible way to manage or revive Katsuura city or cities similar to Katsuura city in Japan.



**Reference:**

Alan Mace, Nick Gallent, Peter Hall, Lucas Porsch, Reiner Braun, and Ulrich Pfeiffer, 2004, *Shrinking to grow? The urban regeneration challenge in Leipzig and Manchester*. Anglo-German Foundation for the study of industrial society.

Buhnik Sophie (2011). From shrinking cities to toshi no shukusho: identifying patterns of urban shrinkage in the Osaka metropolitan area. *Berkeley Planning Journal*, 23(1)

Brent D. Ryan (2008). The restructuring of Detroit: city block form change in a shrinking city, 1900-2000. *Urban Design international*: 1-13

Cunningham-Sabot E. and Fol S. 2009 “Shrinking Cities in France and Great Britain: A silent Process ?” *Berkeley*, 69-79.

Cameron, A. C., and P. K. Trivedi. 2005. *Microeconometrics: Methods and Applications*. New York: Cambridge University Press.

Dieter Rink, Annegret Haase, Matthias Bernt, Thomas Arndt, and Johanna Ludwig (2011). *Urban shrinkage in Halle, Germany*. Research report, EU 7 FP Project Shrink Smart (contract no. 226193), WP2

David Streitfeld, 2009, *An effort to save Flint, Mich., by shrinking it*. NY times.

Greene, W. H. *Econometric Analysis*. 6th ed. Upper Saddle River, NJ: Prentice–Hall, 2008

Ivonne Audirac, 2009, *Urban Shrinkage Amid Fast Metropolitan Growth (Two Faces of Contemporary Urbanism)*, *The Future of Shrinking Cities: Problems, Patterns and Strategies of Urban Transformation in a Global Context*

Joseph Schilling, 2009, *Blueprint Buffalo—Using Green Infrastructure to Reclaim America’s Shrinking Cities*, *The Future of Shrinking Cities: Problems, Patterns and Strategies of Urban Transformation in a Global Context*

Jenks M, Burton E., and Williams K., (Ed.) (1996). *The compact city—A sustainable urban form?*

Jochem F.M. and Van der Waals, 2000, *the compact city and the environment: a review*, Royal Dutch Geographic Society

Justin B. Hollander , Karina Pallagst and Terry Schwarz. 2009, *Planning Shrinking Cities*

Katz, Peter (ed.). (1994) *The New Urbanism: Toward an Architecture of Community*. New York: McGraw-Hill.

Keiro Hattori (2010). *Shrinking city phenomena of Japan in Macro-Perspective*

Lienhard Lotscher, Frank Howest, Ludger Basten, 2004, *Eisenhüttenstadt: Monitoring a shrinking German city*. *Dela* 21, 361-370

Laura Schatz (2008). *Innovation in the face of population decline: ‘Smart shrinkage ’ in Youngstown, Ohio*.

Long, J. S., and J. Freese. 2006. *Regression Models for Categorical Dependent Variables Using Stata*. 2nd ed. College Station, TX: Stata Press.

Marco Bontje, 2004, Facing the challenge of shrinking cities in East Germany: The case of Leipzig, *Geojournal*, Volume 61

McCarthy, J. 1998, Reconstruction, regeneration and re-imaging: the case of Rotterdam, *Cities*, Vol. 15, no. 5, pp. 337-344

Moche Ben-Akiva and Steven R. Lerman 1987, *Discrete choice analysis: theory and application to travel demand*. The MIT Press

NIPSSR (National Institute of Population and Social Security Research). 1997 *Population Projections for Japan: 1996–2100*, Research Series No. 291, 1997

New urbanism, <http://www.newurbanism.org/>, accessed in March 2012

Oswalt, P and T. Rieniets. 2007. Global context. *ShrinkingCities*. <[http://www.shrinkingcities.com/globaler\\_kontext.0.html?&L=1](http://www.shrinkingcities.com/globaler_kontext.0.html?&L=1)> . Accessed Oct. 10 2011

Oswalt P. (eds) 2008 *Shrinking Cities Complete Works 3, Case Study : Japan*, Project Office Philipp Oswalt, Berlin.

Robert A. Beauregard (2009). Shrinking cities in the United States in historical perspective: a research note. In : Pallagst et al. (eds), *op.cit.*, pp.61-78

Rollin Stanly, 2010, Planning & urban design agency, City of st. Louis, Planning and policy-making for shrinking cities: *e=mc2 the relative city*

Sigrun Kabisch, Annegret Haase and Dagmar Haase. 2006, *Beyond growth-urban development in shrinking cities as a challenge for modeling approaches*

Wiechmann T. 2009 “Conversion Strategies under Uncertainty in Post-Socialist Shrinking Cities: the Example of Dresden in Eastern Germany.” In : Pallagst et al. (eds), *op.cit.*, pp.69-79

Wiechmann Thorsren, 2010, *Conversion strategies under uncertainty in post-socialist shrinking cities: the example of Dresden in East Germany*, Brandenburg Technial University

Winfried Fliichter (2010). *Shrinking cities in Japan: between megalopolises and rural peripheries*.

Williams, K., Burton, E., & Jenks, M. (2000). “Achieving the compact city through intensification: An acceptable option?”. In M. Jenks, et al. (Eds.), *The compact city—a sustainable urban form?*

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# **Sustainable Transport: A case of Rickshaw Pullers with Sammaan Foundation**

By

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&

Arun Sahay

## Track 5b: Sustainable Transport: Innovation and Integration

### Abstract

This race of faster and better transport has grave implications on our planet. The resources are getting depleted and carbon emission is going on increasing. The ecological imbalance is already taking its toll. This emphasizes the need of a sustainable mode of transport. While exploring the option for transport, it has been discovered that the Cycle Rickshaw has one of the lightest carbon foot prints. This vehicle for smaller distance can not only reduce the strain on fossil fuel but can also lead towards lesser polluted environment. Further, it may help in marginally bolstering economy, especially of non oil producing nations.

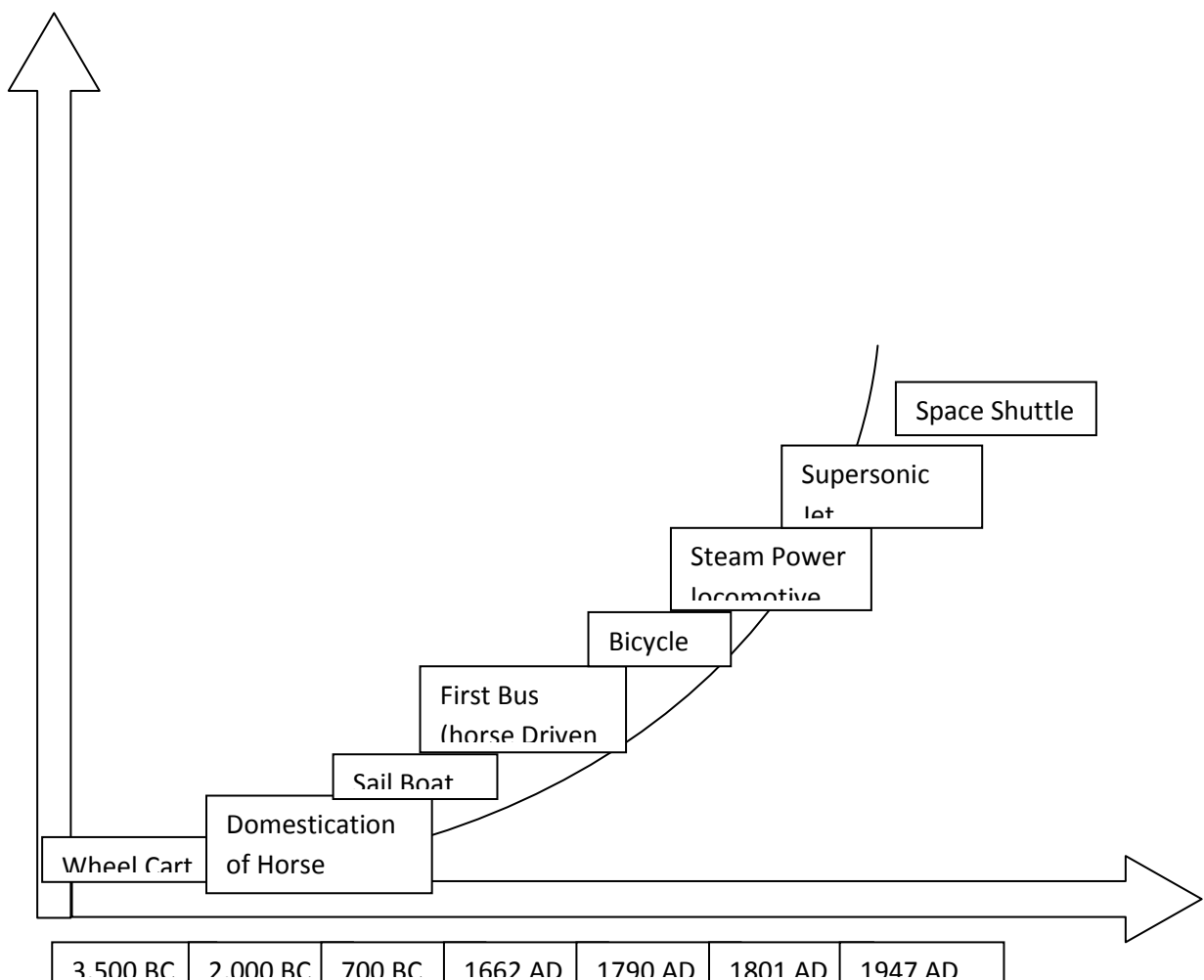
However, rickshaw pullers have their own problems and cycle rickshaw their own limitations. Cycle Rickshaw cannot be a substitute of motorized vehicle but it supports a big number of human beings in various countries. Therefore, it is important to ensure the sustainability of this vehicle as well as the person to whom it provides livelihood. This paper is an attempt to look into the issues which create hindrance in the sustenance of cycle rickshaw transport.

The study has been case based. One organization, Sammaan Foundation, which is working towards solving various issues related to rickshaw transport and delves into the socio-economic life of the rickshaw pullers, has been chosen for this study. The study leads to a finding that social enterprise can handle sustainability of rickshaw which is a sustainable transport. However, it leaves a question; whether a social enterprise can scale up sustainable transport addressing all its components.

Key words: Sustainability, Sustainable transport, Rickshaw Transport, Social Enterprise,

## INTRODUCTION

Since ages transportation has been an integral part of mankind. It is a sign of growth. History has been a witness to the changing shape of human life with the change in the transportation. It all started when humans realized the limit of their physical strength. They deployed animals to help in commuting or carrying things. To progress the matter further in 3,500 BC the wheel was invented. This helped in speeding up the development process. Wheel became one of the greatest inventions. The man and animal driven carts came in to exist. This made carrying goods from one place to another easier. The mankind never looked back and kept on finding modes of transport which are faster and better. The journey of different mode of transportation can be depicted as



This race for faster and better transport has grave implications on our planet. The resources are getting depleted. The change in fossil fuel prices is rocking the economies. The ecological imbalance has also started showing its sign.

This stressed the need to find sustainable solutions which can strike a balance between growth & environmental concerns. To find these solutions it is important to know 'what is sustainability?'

According to Beatley (1995), there is no definition of sustainability, sustainable development or sustainable transport which is accepted universally. It has been defined by many authors. One of the widely accepted definitions is given by Brundtland Commission (1987). It defines Sustainable development as "meeting the needs of the present without compromising the ability of future generations to meet their own needs." This definition is comprehensive but it does not elaborate on the different aspects of the term. Another definition which is more explicit is "Sustainable development is the achievement of continued economic development without detriment to the environmental and natural resources." (Themes: Sustainable Development, 2004). Both of these definitions talk about environmental aspects only.

'The World Bank' defines it by including environmental, social, and economic dimensions of sustainability (World Bank 1996). Litman and Burwell (2006) have stated that the issues under each category (i.e. environmental, social, and economic) may overlap in practice.

There are different sectors which have impact on sustainability. With one fifth of worldwide GHG emissions coming from transportation, this area has crucial implications for sustainability (Sperling and Cannon 2009). According to Todd & Burwell (2006), the term *sustainability* and its implications for transport planning is gaining momentum. This crucial area has started getting attention. People have started looking at the different methods of measuring and reducing impact of transportation on environment. However, before going into the implication of transport on sustainability, scope of sustainable transport needs to be defined.

#### SUSTAINABLE TRANSPORT

A narrow definition of sustainable transport tends to favour individual technological solutions, while a broader definition tends to favour more integrated solutions, including improved travel choices, economic incentives, institutional reforms as well as technological innovation (Litman & Burwell, 2006). It is essential to have a balance between focus and scope of the topic. "The goal of sustainable transportation is to ensure that environmental, social and economic considerations are factored into decisions affecting transportation activity." (MOST, 1999).

There was a belief that all three of these (i.e. environmental, social and economic) cannot be achieved simultaneously. There is a tradeoff between these considerations which a transportation mode has to face. But Boarnet (1997) states that marginal productivity of increased travel is decreasing and some times the cost of usage of a vehicle exceeds the economic gain.

To achieve sustainable transport the dependency on automobile should be reduced as this dependency imposes various economic, social and environmental costs (Newman and Kenworthy, 1998). CO<sub>2</sub> emission of a mode transport can be depicted in an increasing order as:

Walk → Bicycle → Cycle Rickshaw → Train → Bus → Automobile → Air Plane

This shows that Cycle Rickshaw has one of the lightest carbon foot prints. Thus, by encouraging the usage of rickshaw for smaller distance, not only strain on environment be reduced but also employment could be generated. However, the sustainability of rickshaw puller itself is a question.

This motivated the authors to explore this mode of transport a little further. It was found that these non-polluting vehicles are being replaced by polluting (both air and noise wise) petrol and diesel-powered three-wheelers (Rajvanshi, 2002). This indicated that before proposing rickshaw as a substitute of motorized vehicle, it is important to ensure the sustainability of this mode of transport. The paper attempts to look into the issues rickshaw as well as rickshaw puller.

#### RICKSHAW and RICKSHAW PULLERS

The concept of tricycle rickshaw is not new or novel. But there are very few attempts to make it a good reply to environment-degrading fossil fuel vehicles. This vehicle has potential in terms of providing sustainable transport for small distance local travel. Still this authority in cities, generally try to push them out. When social activists make a hue and cry, they reappear. No doubt, if we talk of an inclusive society, they need greater attention.

The existing studies on rickshaw pullers are very few and the studies related to their contribution in providing sustainable transport are almost nonexistent in India (Kurosaki, et. al. 2007). This research gap combined with the potential of rickshaw as sustainable transport for small distances convinced the authors of this paper that there is a need and valid reason for research in this area. After initial research it was evident that there is a strong relationship between the life of rickshaw pullers and rickshaw.

For making transport by rickshaw sustainable, it is important to understand the problems and issues faced by rickshaw pullers. Further, there is a need to study various forms of social enterprise, especially, that in 'Livelihood Sector' as also the definition of lifestyle.

### LIFE STYLE

The word lifestyle means the typical way of life of an individual, group or culture (Merriam- Webster Dictionary). The lifestyle relates to the economic level at which people live, how they spend their money, and how they allocate their time (Anderson and Golden, 1984). Other than economic factor, there are factors which affect the life of anyone. These factors include social factor and basic demographic characteristics (Kucukemiroglu, 1999). The demographic and socio-economic factors get widely accepted and used in many studies because of their easy quantification. But many researchers (Westfall, 1962; Wells 1975) believe that there is a need to supplement these factors with other case specific factors.

Thus, for studying the lifestyle of rickshaw pullers, factors like technical, Health and working conditions have been considered. These factors were explored in related literature and in-depth interviews.

### ISSUES RELATED TO LIFESTYLE OF RICKSHAW PULLER

#### Technical

The existing cycle rickshaw has hardly changed since it was introduced in India in the early 1920's from Far East (rickshaw is derived from the Japanese word *jinriksha*, which means hand drawn cart (Rajvanshi, 2002). Thus, most of the rickshaws are primitive with lowest level of technology. This results in higher level of effort by rickshaw pullers in transporting passengers from one place to the other.

The average weight of a traditional cycle rickshaw was 145 kg. It required massive energy to move the vehicle with passengers sitting in it. Load being the same, higher weight of rickshaw



resulted in lower speed with the same effort. The design, too, was not user friendly. The rickshaw puller had no space to keep things he needed like water. The seating arrangement was very uncomfortable and the bulky frame made the aerodynamic drag very high (Rajvanshi, 2002).

The frequent breakages in rickshaw at some common points were regular. The reason was that the rickshaw manufacturing was an unorganized footpath industry with no quality control. These rickshaws were so poorly made that they had to be replaced completely in about two years (Rajvanshi, 2002).

#### Economical

Buying a rickshaw was not perceived to be a sensible investment by the rickshaw pullers (Begum, and Sen, 2004). The registration cost, maintenance cost and lack of any identification proof were some of the reasons behind it. Thus, majority of rickshaw pullers did not own a cycle rickshaw; they rented it from an owner-contractor. The contractor, as he was taking high risk by employing people without any identification proof, charged very high rent. The rent was, usually, charged on daily or weekly basis so that the amount did not appear to be big.

This lack of identification proof also debarred them from access to any banking support. The bank did not recognize them and no other person was ready to be their guarantor. As a result, they deposited their savings with the only person trusting them, the contractor. Many times they got cheated by them and they none to complain to. Brijlal, one of the rickshaw pullers in Patna said, "The contractor never returns us our total money. He keeps back some amount saying that he does not have it at that moment. Later on he denies having remaining money". Many of them had similar experience with the contractor.

#### Social

A very large number of people in this sector were poor; rural-to-urban migrants. These migrants had very little education and skills so rickshaw pulling provides an easy job opportunity and an escape from the rural poverty. Thus, in the absence of any other option, they chose this as their urban career. Because of their migrant status, they had almost non-existent social security. In case of any exigency they did not have any one to relay on.

#### Health

The food intake of rickshaw pullers was barely sufficient for survival. Their meal lacked nutrition required for physical labor. Many of them drank alcohol or took drugs to get the instant high to put in massive amount of slog required. These things made them vulnerable to systematic health risks (Begum and Sen, 2004).

#### Demographical

Majority of the rickshaw pullers belonged to the 16 to 45 years of age group. The reason for this was the physical stamina required for the job. The age and physical strength affected their income as well. As the rickshaw puller got old his income reduced drastically.

### Working conditions

The working hours were also not defined. Rickshaw pullers could decide it as per his convenience. Most of them were illiterate or semi literate. Mostly they were unaware of the traffic rules. This gives the police a chance to harass and exploit them.

Many of them were migrants so they did not have proper place to stay. They rented rickshaw for 24 hours and most often slept in that. The high maintenance cost and complex registration process of rickshaw kept rickshaw pullers from owning the rickshaw.

All these issues indicated towards a structural problem which needed to be solved only by revolutionizing the whole set-up. As per the definition of social entrepreneur by Bill Drayton<sup>1</sup> (Bornstein, 2006), this sector needed a leader; a social entrepreneur. Mr. Irfan Alam of 'SammaaN foundation' is one such entrepreneur who has been trying to change this socio-economic sector drastically.

## SammaaN Foundation

### Idea stage

The idea of bringing a socio-economic transformation in this sector struck him when the founder of 'SammaaN Foundation', Mr. Irfan Alam, on a very hot Indian summer day in 2006, asked for water from the rickshaw puller. Obviously, the cycle rickshaw puller was not carrying any water. Thirsty Irfan got determined to improve the services in a cycle rickshaw. He thought of some basic facilities which could be provided in the rickshaw. Their meager income was another area of concern. He was wondering how to increase their income. He did not spend much time in thinking and quickly prepared a business plan to implement his ideas.

To test this business plan, he participated in a famous reality show on business plans called 'Business Bazigar' on a national television channel. To his utter surprise, he went on to win the competition. The promoters of the show offered him money to sell this idea and/or work with them as an employee on this venture. Irfan had some other thoughts. He wanted to realize his

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<sup>1</sup> Social entrepreneurs are not content just to give a fish or teach how to fish. They will not rest until they have revolutionized the fishing industry."

plans through a social venture; he wanted to take it forward on his own terms. He refused big money and other offers to fulfill his dream himself.

### Sustainability of the idea

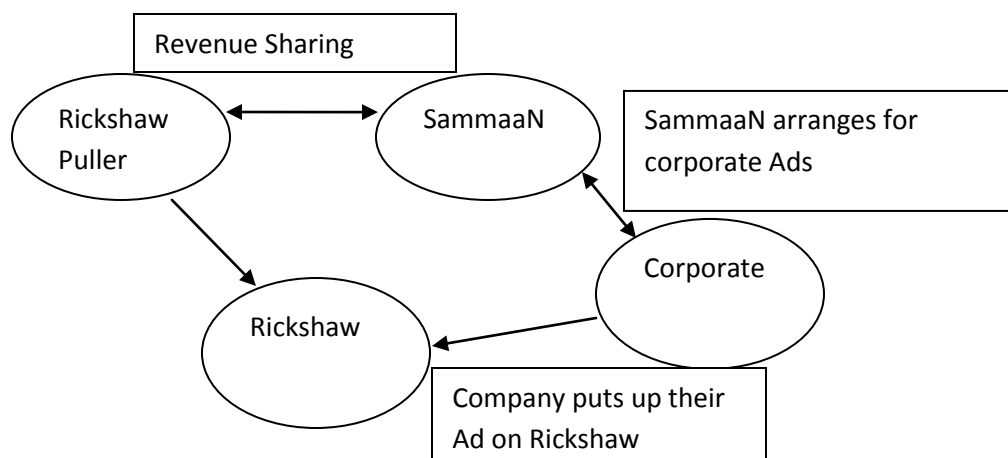
When he started exploring the opportunity for execution, he came face to face with the harsh reality of rickshaw pullers' life. The issues related to their lives were far more depressing than expected. The issues were much more completed than stated above. Immediate intervention was needed. Irfan immediately created SammaanN Foundation which started its operations on 25<sup>th</sup> January 2007 in tier 2 city called Patna in India (See Annexure 1 to know more). He decided work on environmental, social, and economic dimensions of the problem; he had undertaken to solve (World Bank 1996). He was convinced that the solution would never be successful unless all the three aspects were covered.

The first aim was to organize the rickshaw pullers and work towards improving their economic condition. Simultaneously, SammaanN Foundation was also working on the improvement of the design of the rickshaw. They wanted to make cycle rickshaw stand in the competition of three wheeler auto-rickshaw.

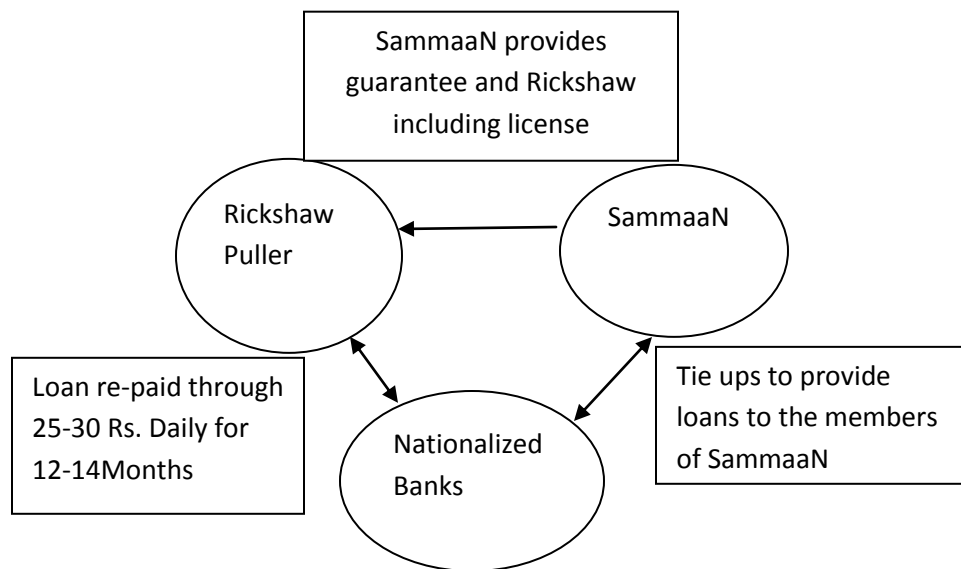
The first round of funding came from family. Irfan had a knack for business. He had started his first company when he was just 13years of age. That was the reason family trusted him. In the second phase focus goes to address the social issues one by one.

### The Business Model

Irfan believed in the potential of the bottom of the pyramid (Prahlad.....) customer. He thought that if their earnings will improve their spending will also improve. This motivated him to create a business model that will help the most neglected section of Indian society. Working with them Irfan created different business models and went on innovating them. First of those model was Advertising revenue sharing Model. In this model, different places of rickshaw were identified as advertising board. SammaanN approached various businesses and negotiates with them a good price. The relationships created in his initial model are depicted below.



He improved upon it to make the rickshaw puller the owner of the rickshaw. In 'Ownership Model', SammaanN tied up with nationalized banks for providing loan to the rickshaw pullers with them. SammaanN acted as the guarantor for them. It also ensured that the rickshaw pullers keep repaying installments of their loan.



## RESEARCH DESIGN

This investigation is an exploratory study with a focus on the major issues related to lifestyle of rickshaw pullers. The idea was to identify factors which are hindrances in making rickshaw a more sustainable transport. These factors have been identified by literature review and in depth interviews conducted with people concerned. The next step was to study the measures taken up by SammaanN to solve the problems arisen within these factors.

## METHODOLOGY

Initially in depth interviews with Founder and the other team members of SammaanN Foundation were conducted. The secondary data about the rickshaw pullers, independent of SammaanN, were also collected. These interviews and secondary data gave the factors which were needed to be addressed to make rickshaw transport sustainable.

Based on these interviews and literature a semi-structured interview was conducted with rickshaw pullers & other people related to Sammaan Foundation. The results showed which of these issues were addressed by Sammaan and to what extent.

#### ANALYSIS and SUMMARY

The research yielded that Sammaan Foundation has made efforts to address the issues identified by the literature and the exploratory research. The issue wise steps taken by Sammaan can be given as under.

##### Technical Changes

Summaan Foundation worked on the design and made it weigh 70 -75 kg, half of the existing weight. The design also gave enough space to rickshaw pullers to keep needed things. This new rickshaw had provision of first aid box, newspaper and water bottle. They also introduced a small radio transistor in the vehicle. To remove the problem of frequent breakages, they have attained a limited success and are still working with designers, engineers and users. In pursuance of weight reduction and quality improvement, they have also set-up a rickshaw manufacturing unit which is producing the improved rickshaw with higher quality at lower cost.

##### Economical Changes

The rickshaw pullers working with Sammaan get an identity card. The identity card is issued to them after a thorough background check. In case of migrants, the background check is done with the other native rickshaw puller already registered with Sammaan. This identity card and support from the organization helped rickshaw pullers in opening bank account and access to other financial resource. Sammaan, also, encouraged the rickshaw pullers to buy the rickshaw so that they could earn more.

To help them in buying rickshaw, Sammaan works on different revenue sharing models. Depending on the revenue sharing model, the Foundation bears the maintenance cost which is provided by them free to the rickshaw pullers. In case of any accident the Rickshaw Pullers can get the insurance claim for damages.

##### Social Changes

SammaaN organizes a weekly meeting of the rickshaw pullers. In this informal gathering they talk about their problems and their experiences. Here only they also discuss the possible solution to problems, with collective wisdom. Fortnightly meeting called 'SammaaN Shabha' are

also organized. In these meetings, different topics like traffic rules, education, gender equity or anti-intoxicant campaign are taken up.

It has opened a new socio-economic frontier where the wives of rickshaw pullers are given vocational training for increasing the income of household.

#### Working Condition

Rickshaw pullers have got social recognition because of “SammaaN. They have got a chance to lead a dignified life. No policeman can unnecessarily harass them now. “They have somebody to back them up”, says Chandu, one of the rickshaw puller working with Sammaan. Chandu has also given tour to former US president Mr. Bill Clinton on his rickshaw during his visit to the office of Sammaan. Foundation has now 24 hour help line where rickshaw pullers can report in case of any exigencies. The nearest patrolling employee of Sammaan reaches to help them in solving the issue.

#### Health

One frequent problem Sammaan faced was of medical facility. The rickshaw pullers face lot of health issues due to unhygienic living condition, malnutrition and poverty. When rickshaw pullers fall ill and they have to face lot of difficulty in getting themselves admitted in the government hospital. The private hospitals are very costly. This inspired Sammaan to start a mobile medical unit. After seeing their efficient operation, Government gave them responsibility for running the government scheme of mobile medical unit called ‘Danvantary’ for the city of Patna.

The outcome of the study could be summarized in the following table.

LIFESTYLE FACTORS	PROBLEMS	SOLUTION BY SAMMAAN
Technical	<ol style="list-style-type: none"><li>1. Weight of Rickshaw</li><li>2. Poor quality and design</li><li>3. Frequent breakdowns</li></ol>	<ol style="list-style-type: none"><li>1. Re-designed light weight Rickshaw</li><li>2. A manufacturing unit (which repairs as well) set up</li><li>3. Working on the design and quality problems with experts</li></ol>

Economical	<ul style="list-style-type: none"> <li>4. High rental</li> <li>5. Maintenance or accidental damage cost</li> <li>6. No safe place to keep the savings</li> <li>7. Low income</li> </ul>	<ul style="list-style-type: none"> <li>4. Derived different Business Model to let the Rickshaw Pullers own the rickshaw</li> <li>5. Foundation bears the maintenance cost and gets the Rickshaw Pullers insured for accidental damages</li> <li>6. Helped in opening Bank account</li> <li>7. Different Business techniques are used to increase the income. Wife of rickshaw pullers are also given vocational training for increasing the income of household</li> </ul>
Demographic	<ul style="list-style-type: none"> <li>8. Income reduces as the puller gets old</li> <li>9. Majority of Rickshaw Pullers are migrants having no identity proof</li> </ul>	<ul style="list-style-type: none"> <li>8. Awareness drives were taken up to encourage the savings for old age</li> <li>9. After background check from the native place of migrant, Sammaan Identity Card is issued</li> </ul>
Social	<ul style="list-style-type: none"> <li>10. Non-existent social security</li> <li>11. Lack of education</li> <li>12. Unstable living condition</li> </ul>	<ul style="list-style-type: none"> <li>10. Sammaan Shabhas are organized to create a network of rickshaw pullers</li> <li>11. Night schools are run</li> <li>12. Rickshaw Center 'Raien Basera' (where the rickshaws are parked) have some place where these rickshaw pullers can stay</li> </ul>
Working Condition	<ul style="list-style-type: none"> <li>13. No knowledge of traffic rules</li> <li>14. Police exploitation</li> <li>15. Complex registration process</li> </ul>	<ul style="list-style-type: none"> <li>13. In Sammaan Shabha special module on traffic rules are conducted</li> <li>14. Associated rickshaw pullers wear uniforms and carry documents. If any police man tries to harass then foundation</li> </ul>

	16. Security issues	<p>intervenes</p> <p>15. Sammaan helps them in the registration process</p> <p>16. Foundation has 24 hour help line where rickshaw pullers can report and the nearest volunteers help them in solving the issue</p>
Health	<p>17. Systematic health risk due to poor living condition</p> <p>18. Use of intoxicant</p> <p>19. Accidental injury</p> <p>20. High cost of medical facilities and common diseases</p>	<p>17. At 'Raine Basera' quality food is offered at affordable prices. The wives of rickshaw pullers prepare the food</p> <p>18. Sammaan Shabha launches different anti-intoxicant campaigns</p> <p>19. Accidental insurance helps</p> <p>20. Sammaan runs a Mobile Medical Unit (MMU) in different slums of Patna</p>

## CONCLUSION

The efforts made by Mr. Irfan Alam and the team of Sammaan Foundation are creating some impact on the lives of rickshaw puller as well as making an impact, however small, on the transport sector. Their systems and processes are continuously improving. With millions of rickshaw running in various parts of the world, Sammaan needs to scale up. The market for sustainability is huge, whether it is sustainability of earth, a corporate, an entrepreneur or an individual.

Sammaan's quest to make Rickshaw a sustainable transport for local travel is unique. For his efforts, Mr. Alam has been recognized as an Ashoka fellow, but he needs to move up on the business front. Though he is trying to get solar panel fitted on rickshaw to improve their present drudgery but the cost of that technology makes it unaffordable with the current business model. Many agencies wanted to give him grants but Mr. Alam is not in favour of taking any grants. He is determined to make self-sustaining business. May be, one day his efforts will make it really a sustainable transport for short distances.



This leaves a question; how a social enterprise can take such efforts further that have social, economical and environmental act, simultaneously dealing with the issue of inclusiveness.

## References

Anderson, W.T. and Golden, L. (1984), ``Life-style and psychographics: a critical review and recommendation'', in Kinnear, T. (Ed.), *Advances in Consumer Research*, XI, Association for Consumer Research, Ann Arbor, MI, pp. 405-11

Beatley, T. (1995) 'The many meanings of sustainability', *Journal of Planning Literature*, May,

Begum, S. and Sen, B. (2004). "Unsustainable Livelihoods, Health Shocks and Urban Chronic Poverty: Rickshaw Pullers as a Case Study" CPRC Working Paper 46,

Besley, Timothy and Burgess, Robin (2003). "Halving Global Poverty." *Journal of Economic Perspectives*, Vol. 17, No. 3, pp.3-22

Boarnet, M. (1997) 'New highways & economic productivity: interpreting recent evidence', *Journal of Planning Literature*, May, Vol. 11, No. 4, pp.476–486.

Bornstein, David. 2004. *How to change the world: social entrepreneurs and the power of new ideas*. Oxford; New York: Oxford University Press

Kucukemiroglu, Orsay (1999), "Market segmentation by using consumer lifestyle dimensions and ethnocentrism: An empirical study", *European Journal of Marketing*, Vol. 33 Iss: 5 pp. 470 – 487

Kurosaki, T. Sawada, Y. Banerji, A. and Mishra, S.N. (2007). "Rural-Urban Migration and Urban Poverty: Socio-Economic Profiles of Rickshaw Pullers and Owner-Contractors in North-East Delhi", retrieved from <http://www.ier.hit-u.ac.jp/~kurosaki/rick0702.pdf> on 1st February 2012

Masum, M., 1988, *Informal Financial Markets in Rural Bangladesh: The case of Rickshaws*, Working paper No. 13, BIDS, Dhaka

Mitra, Siddhartha (2002). "Lessons in Regulating the Informal Sector: The Case of Rickshaw Pullers' Sector in Delhi," *Indian Journal of Labour Economics*, 45(2), pp.387-94

Newman, P. and Kenworthy, J. (1998) *Sustainability and Cities; Overcoming Automobile Dependency*, Island Press, Covelo, [www.islandpress.org](http://www.islandpress.org)

Prahalad, C.K. (2009), *The Fortune at the Bottom of the Pyramid: Eradicating Poverty Through Profits* (5<sup>th</sup> Anniversary edition)

Rabbani, Golam et. al, 1997, Health Care Expenditure in Bangladesh, Research Monograph Series No. 10, BBS, Dhaka.

Rajvanshi, A. K. (2002). "Electric and improved cycle rickshaw as a sustainable transport system for India", CURRENT SCIENCE, Vol. 83, NO. 6

Sperling D, Cannon J. (eds.). 2009. Reducing Climate Impacts in the Transportation Sector. New York: Springer.

The World Bank (1996). Sustainable transport: Priorities for policy reform. Washington, D.C.: The World Bank

Themes: Sustainable Development (2004) European Foundation for the Improvement of Living and Working Conditions, <http://susdev.eurofound>

Todd Litman and David Burwell (2006), "Issues in Sustainable Transportation," *International Journal of Global Environmental Issues*, Vol. 6, No. 4, pp. 331-347; at [www.vtpi.org/sus\\_iss.pdf](http://www.vtpi.org/sus_iss.pdf)  
Vol. 9, No. 4, pp.339–342

Westfall, R. (1962), "Psychological factors in predicting product choice", *Journal of Marketing*, April, pp. 34-40

#### Annexure 1



Map of India showing Patna, Bihar.

**Proceedings of the 18<sup>th</sup> Annual International Sustainable Development Research Conference, University of Hull, Hull, UK, 24 – 26 June 2012;  
Track 5b**

**Sustainable development and airport surface access – the role of technological innovation and behavioural change**

**Paper for the 18<sup>th</sup> Annual International Sustainable Development Research Conference, University of Hull, 24-26 June 2012**

**Track 5b: Sustainable Transport: Innovation and Integration**

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**Abstract**

Sustainable development has an underlying tension to achieve economic growth whilst addressing environmental challenges, and this is particularly the case for the aviation sector. Although much of the aviation-related focus has fallen on reducing aircraft emissions, airports have also been under increasing pressure to support the vision of a low carbon energy future. One of the main sources of airport-related emissions is from passenger journeys to and from airports (the surface access component of air travel), the focus of this paper. Two aspects associated with the relationship between sustainable development and airport surface access are considered. Firstly, there is an evaluation of three technology innovation options that will enable sustainable transport solutions for surface access journeys: telepresence systems to reduce drop-off/pick-up trips, techniques to improve public transport and options to encourage the sharing of rides. Secondly, the role of behavioural change for surface access journeys from a theoretical perspective, using empirical data from Manchester airport, is evaluated. Finally, the contribution of technology and behavioural intervention measures to improvements in sustainable development are discussed.

## **Introduction**

Sustainable development reflects an underlying tension between achieving economic growth whilst also addressing environmental challenges, and this is particularly the case for the aviation sector. Although the sector is largely considered to be economically and socially sustainable, it also generates environmental concerns because of climate change impacts from aviation-related emissions. Despite a dip due to the current economic recession, United Kingdom air travel has increased over the last ten years (219 million terminal passengers at UK airport in 2011 compared with 167 million in 1999 – CAA, 2012). It is also likely to experience a long-term growth in demand with a knock-on impact on emissions such as carbon dioxide (CO<sub>2</sub>). Although much of the aviation-related focus has fallen on reducing aircraft emissions, airports have been under increasing pressure to support the vision of low carbon energy future. In particular, in recent years there has been a focus on reducing the share of emissions from surface access journeys to and from the airport.

This paper contains an initial review of the issues surrounding sustainable development and airport surface access. It focuses on two aspects: an evaluation of the technology innovation options that will enable sustainable transport solutions for surface access trips, and a discussion on the role of behavioural change for these journeys from a theoretical perspective using empirical data from Manchester airport. Finally the potential contribution of technology and behavioural intervention measures to improvements in sustainable development relating to surface access is discussed.

This paper presents findings from one of a series of Airport Operations projects (funded by the United Kingdom Research Councils' Energy Programme), the 'ABC project: Airports and Behavioural Change: towards environmental surface access travel'. The project aims to encourage better environmental behaviour of individuals travelling to and from airports (the surface access component of air travel), and has a focus on sustainable transport solutions for the year 2020, a mid-term timescale. A unique aspect of the ABC project is that it brings together two components, surface transport and air travel, as each transport component has environment imperatives to reduce both travel demand and carbon emissions.

## **Sustainable development and airport surface access**

Climate change has had an increased role over time within the environmental aspects of sustainable development, as shown by its more prominent role within the 2005 UK Sustainable Development Strategy (Department for Environment, Food and Rural Affairs, 2005). Transport is a major contributor to greenhouse and pollutant emissions, and transport is one of the only sectors where emissions have been increasing. This is especially the case for aviation. While it is estimated that commercial air travel currently accounts for around 2% of global CO<sub>2</sub> emissions (reference), it is expected that this figure will rise given the projected growth of the sector in the medium to long term.

The UK Government's commitment to reduce CO<sub>2</sub> emissions by 80% by 2050 over 1990 levels, with an interim target of a 34% reduction by 2020, has put the issue of aviation related emissions into focus. Given the projected growth in the sector, it is likely that aviation will take an increasingly significant proportion of any carbon budget (Anderson et al., 2007). UK Government estimates forecast growth in UK aviation to double carbon emissions from approximately 9 million tonnes of carbon (MtC) in 2000 to 17.4 MtC in 2050 (Department for Transport, 2004).

It should be noted that there are many significant environmental impacts of air transport including, amongst others, the development of airports and associated infrastructure; noise and vibration from aircraft (and surface access); water pollution (e.g. surface run-off); local air quality pollutants (e.g. CO, NO<sub>x</sub>); solid waste (scrapped aircraft, waste oil / tyres); other waste for disposal; energy and water consumption; and complex land-based supply chain operations. The focus of this research is on the role of the airport within the aviation system, in developing in a sustainable manner.

One of the immediate necessities to kick start this process is to conduct research in order to understand the key challenges facing airports, and to facilitate the development of solutions. A challenging objective for airports is to develop sustainably, increase airport capacity and economic performance, while simultaneously minimizing environmental impact.

While surface access emissions are relatively small in comparison to those from aircraft, they are one of the primary sources of emissions that airports have the ability to influence. This is why this paper, and the underlying research project from which it stems, focuses on surface access journeys to and from airports.

Access to airports is an essential part of airport operations as well as being of particular importance for travellers. It is estimated that 65% of journeys to large airports in Europe and the US are made by private cars, with this figures rising up to 99% for smaller regional airports (Humphreys and Ison, 2005; Vespermann and Wald, 2011). Importantly, previous studies have demonstrated that the Value of Access Time (VOAT) is considerably higher than the estimated value of time spent travelling normally for commuters (e.g. Koster et al., 2011). The reason for this appears to be the risk of missing flights which increases when travel time to airport increases (Hess and Polak, 2006). Also, it is important to analyse how long before boarding travellers want to be at the airport. This is estimated to depend, in particular, on whether the passenger is flying for business or leisure, with business travellers preferring to arrive later at airport, on whether the passenger is in employment or retired, the frequency of flights in the past and whether the passenger is travelling with luggage or not (Koster et al., 2011).

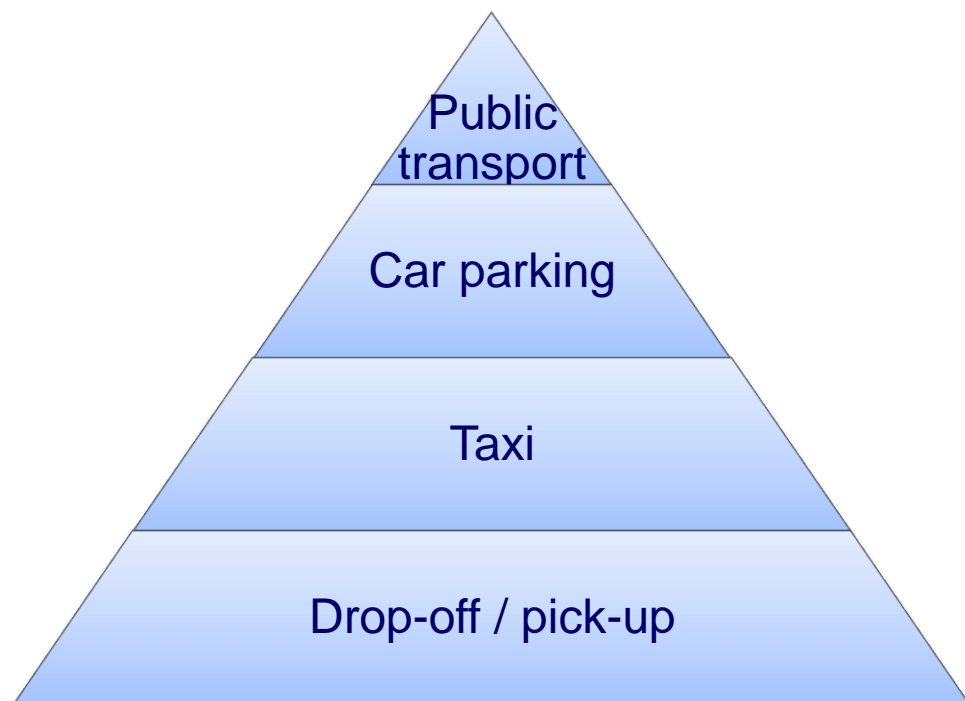
Airport managers face a difficult task with regards to reconciling the congestion and environmental pressures to reduce private vehicle trips with the substantial commercial pressures associated with car parking revenues (Budd et al., 2011a).

Interviews with a range of surface managers at an early stage of the ABC project revealed a wide variety of surface access issues and management policies (Budd et al, 2011b). The need to reduce the share of passenger journeys made by private car and to increase public transport use was identified as a key issue, with a particular focus on reducing ‘drop-off/pick-up’ journeys. However, it was also found that while reducing private car journeys may yield environmental benefits, such strategies are largely at odds with substantial commercial pressures to maximise the revenue potential of airport parking. Particular focus was paid to the problem of changing current surface access travel behaviour among airport users. UK airport surface access managers are reliant on a range of external stakeholders, whom the airport has little direct control over, such as operators of key infrastructure and train companies. Whilst in many cases the airport–stakeholder relationship is shown to be mutually beneficial, airports are still in somewhat of a vulnerable position.

Surface access to airports has a key aspect of reducing access by motorised transport, particularly where it could easily be transferred to alternative modes. Surface access modes under consideration include a range of public transport options such as taxi, bus and rail. The travel behaviour issues for surface access are different from other transport contexts; for instance, when accessing airports individuals will often not use public transport as they have to take bags with them, and hence the need for sufficient luggage storage capacity on board public transport that is visible throughout the journey, or, where appropriate, off-site luggage drop-off facilities

The types of people who use airports can be seen primarily as passengers and employees. For passengers, there is a particular concern with the drop-off / pick-up of air travellers, typically by a family member or friend. This type of journey, together with those by taxi, is double the number of trips by a passenger who travels by car and parks at the airport. Where possible, airports will try to reduce these trips in favour of driving and parking and, ultimately, public transport. Employee surface access issues can vary considerably from those for passengers. Generally, there is very high reliance on private car journeys for airport employees, who typically need to access the airport regularly, reliably, cost effectively and at times of the day that are not always well served by public transport. In the UK airport employees typically have their parking subsidised or paid for by their employer. Figure 1 is a hierarchy of preferred surface access modes for passengers, from the least environmentally sustainable of drop-off / pick-up to the most environmentally sustainable of public transport. It has been adapted from the Manchester Airport Surface Access Strategy

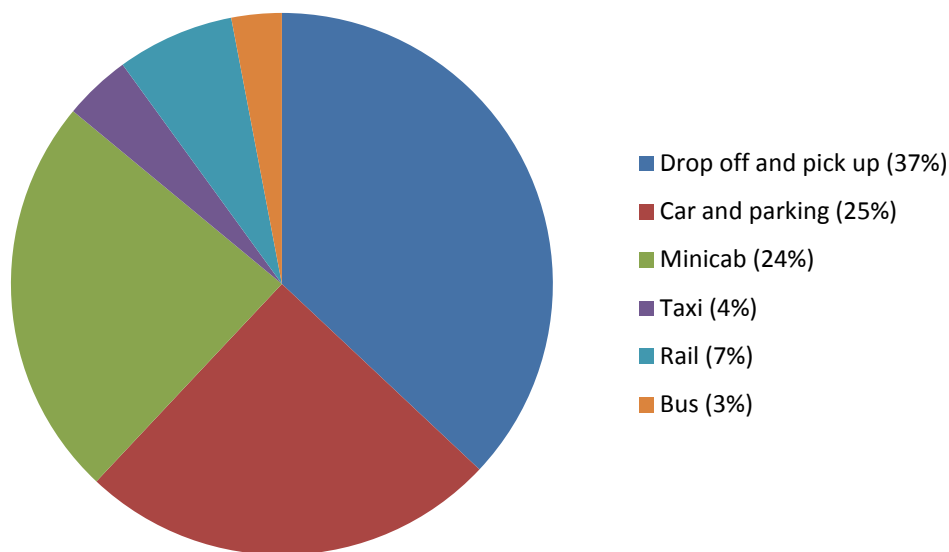
*Figure 1. A hierarchy of surface access modes in order of environmental sustainability (from public transport the most environmentally sustainable to drop-off / pick-up the least environmentally sustainable)*



## A summary of surface access statistics at Manchester airport

Initial work included qualitative interviews at Manchester Airport (together with some also at Robin Hood Doncaster Sheffield Airport). The interviews showed that passengers most likely to drop-off / pick-up, or drive and park, are: holidaymakers, those in groups and/or those with a lot of luggage. Passengers and employees also mentioned the lack of public transport in the early mornings. There has also been some analysis of Manchester airport secondary data from the Civil Aviation Authority (CAA) and employers on the airport site, a literature review, and development of individual carbon footprint calculations. Figure 1 shows the travel mode share for surface access to Manchester Airport (in 2009). It demonstrates the dominance of private transport, which increased from 80% in 1996 to 90% in 2009.

*Figure 1. Travel mode share for passenger surface access to Manchester Airport in 2009 (source CAA data)*



Passenger carbon emission calculations (grams per passenger km in 2009) from CAA data collected at Manchester Airport, by transport mode, shows:

- Highest emissions were from car users, particularly 'Drop-off / pick-up' (221 g/km – 57% of total emissions) & 'taxi' (229 g/km) passengers;
- Emissions per passenger km of 'car and park' (96 g/km) & 'minicab' (67 g/km) users are lower; and
- Rail (77 g/km) and bus (50 g/km) emissions per passenger are the lowest.

Figures for leisure passengers were lower than for business travellers due to higher load factors per car mode.

## An evaluation of technology innovation options

In this section a range of technology innovation options are evaluated that aim to reduce carbon emissions for airport surface access journeys. The following three technology options are evaluated in turn: telepresence (to reduce drop-off / pick-up), techniques to encourage public transport use (e.g. RFID tagging of luggage) and techniques to encourage sharing rides (e.g. software development).

Firstly, there are technologies to provide home telepresence that can reduce the number of surface access trips that involve drop-off / pick-up of passengers. Communications and software tools can be developed to provide a telepresence experience at home using Internet Protocol, home broadband and home sound surround systems. An illustration of a telepresence system that could be installed at an airport is shown in Figure 3.

*Figure 3. Illustrated telepresence system to be installed at an airport*



Rather than travel to an airport to drop-off and pick-up a passenger, relatives or friends could order an on-demand event to say goodbye to the traveller where telepresence can offer a realistic experience. Remote meeting solutions can reduce carbon emissions by cutting the number of travellers and vehicles' users. Many companies currently use tele-conferencing as an alternative to face-to-face meetings. However, remote meeting solutions can suffer from a lack of natural human sense and network quality of service. Telepresence provides an alternative solution by facilitating real-time connections, face-to-face interactions and lifelike size. The lack of natural human sense is minimised and thus this new technology supports people in learning, play, work and meetings with a high quality of service while they are in different locations. Telepresence offers a more 'three-dimensional' experience than standard television viewing. Although some consumers currently use packages such as Skype and iPad facetime, due to the large number of (potential) customers and low bandwidth of the internet user, Skype and other similar applications fail to provide the required quality of service. Telepresence works on dedicated high bandwidth connections, which means that the level of experience is not comparable to Skype and other similar applications.

In addition, relatives or friends in multiple locations could join the event. An increased Internet Protocol television and broadband service penetration is an important enabler for this approach. Airports could offer telepresence suites that include dynamic video, motion sensitive cameras and surround sound, not only for business use but also for the general traveller. Indeed, telepresence is being introduced at some large airports to assist passengers

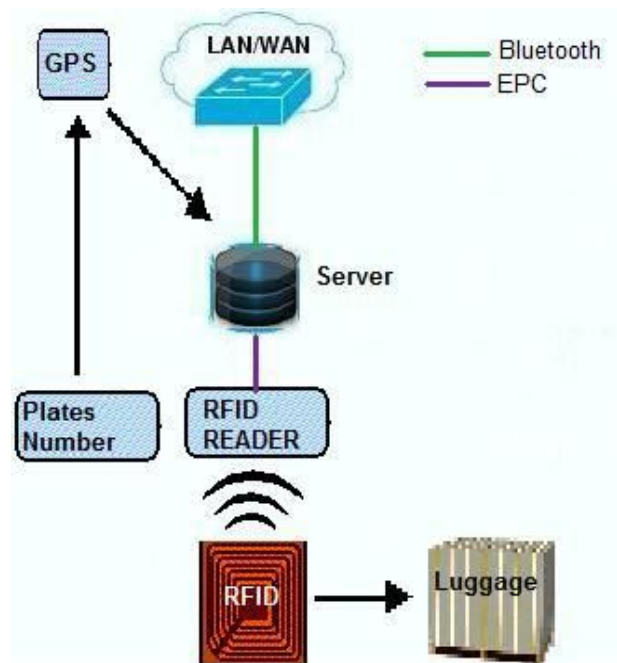


with way-finding (see Future Travel Experience, 2012). This demonstrates that telepresence is a feasible application as a substitute for drop-off / pick-up journeys. Telepresence is at the first level of development and application (there are currently several telepresence providers e.g. Cisco), and so over time is likely to increase in use and reduce in cost. It could, therefore, be a feasible technological application for use at airports in the year 2020.

An important consideration, like other technological innovations, is the extent to which passengers will embrace this particular technology, and their willingness to pay for it. The recent growth of personal video communication via smart phones and tablet computers presents both cause for optimism and caution with this regard. This technology is being investigated within the ABC project in terms of a hypothetical network of base stations within an airport terminal to support telepresence. In an airport environment, passengers act as mobile nodes, moving in random ways and could initiate telepresence. There could be a number of base stations installed to enable high-definition broadband services and good signal coverage for passengers, but this would be at a certain cost.

Secondly, there are technologies to encourage use of public transport (coach or rail). Given that carrying luggage is a significant barrier that can put off passengers from taking public transport for surface access journeys, a remote check-in system could be of assistance. A remote check-in system would be particularly attractive if passengers were able to track and locate their luggage along the journey. To facilitate luggage tracking and identification RFID (radio-frequency identification) technology can be implemented. An illustration of the RFID system that could be installed in trains and/or coaches is shown in Figure 4.

*Figure 4. Illustrated RFID system to be installed in trains/coaches*



Continuous information about luggage location would be available through a web interface or text service. When an air passenger gets to the train (or coach) station on a specified travel date, a Bluetooth auto message would provide the train/coach options to synchronise the passenger and their luggage for the surface access journey. There could be synchronised loading of the luggage onto the train/coach and collection by baggage handlers (or passengers)

at the airport. To avoid security problems, passengers and their luggage could travel on the same coach/train. RFID technology could help to minimise difficulties associated with large numbers of passengers and volumes of luggage at the airport. After the luggage drop-off, RFID will enable passengers and staff to keep track of their luggage during the journey to the airport. This type of system has already been deployed at Hong Kong International Airport, where RFID tags on boarding passes and luggage are utilised for safety, security and travel arrangement purposes.

Thirdly, there are technologies to encourage vehicle sharing. It is common for travellers to form groups when using taxis or (mini) buses for surface access journeys. This simple idea could impact upon carbon emissions for surface access trips. When an individual books air travel, there could also be a choice for them to share surface travel to and/or from the airport, perhaps with people not known to them. An alternative (or complementing system) is for the development of a software tool owned by the airport, for example, that would send messages (email, text) to other passengers within a given geographic radius of each other and with compatible journey times (note that confidential personal information would be removed) to establish willingness to share a surface access journey. Optimum scheduling and route selection software would then match passenger requirements and inform the travellers selected.

### **Understanding behavioural change options**

The second aspect is to develop an understanding of the factors that determine passenger mode choice decisions for journeys to and from airports. There is a need to examine the relative importance of psychological and situational factors as determinants of mode choice for passengers travelling to and from airports. A questionnaire survey of 860 departing air passengers at Manchester Airport was conducted in Summer 2011 to measure psychological constructs pertaining to two well established theories of attitude-behaviour relations, namely the Theory of Planned Behaviour (Ajzen, 1991) and the Norm-Activation Model (Schwartz, 1977). In addition, situational variables relating to various aspects of the passenger's trip, background information about their general travel behaviour, and socio-demographic information were also elicited.

Psychological behavioural models such as the Theory of Planned Behaviour and the Norm-Activation Model have been used extensively in travel behaviour research in recent years. A central assumption of the Theory of Planned Behaviour is that the concept of behavioural intention is *the* key antecedent of actual behaviour. It assumes that if alternative behaviours exist a choice is made based on the relative strengths of the intentions to perform each alternative (Bamberg et al, 2011). The Norm-Activation Model (Schwartz, 1977) takes a very different perspective on behaviour (Abrahamse et al, 2009). While the Theory of Planned Behaviour stresses personal-utility, the Norm-Activation Model focussed on the role of personal morals. The central assumption of the Norm-Activation Model is that feelings of personal moral obligation (known as personal norms) are the only causal determinants of behaviour (Bamberg et al, 2007).

The Theory of Planned Behaviour has been shown to be most suited to decisions that are motivated by personal utility maximisation, whereas the Norm-Activation Model is more suited to behaviours that contain a moral element. Considering that travel behaviour and mode choice is a decision that can involve both of these factors, a number of mode choice studies have employed a joint model that incorporates elements of both theories.

Initially, the Theory of Planned Behaviour and the Norm-Activation Model were tested against the data using structural equation modelling; a statistical technique used to test the structural validity of theoretical models. Results of the analysis indicate that public transport use is determined predominantly by behavioural intentions, as posited in the Theory of Planned Behaviour, rather than personal moral obligations, as suggested in the Norm-Activation Model.

This informed the next stage of analysis where two combined models, containing constructs from both the Theory of Planned Behaviour and the Norm-Activation Model, were tested. In addition, these models also included constructs relating to descriptive norm (perceptions of what is 'normal' behaviour in a population), efficacy (perceptions of what can be achieved) and anticipated feelings of guilt if one were to always use their car to get to the airport instead of using public transport. They were included to see to what extent they improved the predictive power of the models. Results of the structural equation modelling procedure show that, overall, the combined models are useful determinants of public transport use but the additional constructs do not add to their predictive ability.

It is difficult for behavioural models to fully take into account the multitude of situational and socio-demographic variables that affect behaviour. Regarding surface access travel, for example, the purpose of a passenger's trip has been identified as an important mode choice. Business passengers may place a higher value on their time than leisure passengers (Pels et al, 2003; Dresner, 2006), but a lower value on the cost of their trip (Leigh Fisher et al. 2000). Leisure passengers may also be more likely to be carrying heavy luggage with them than business passengers (Brilha, 2008), which may affect their choice of mode.

As a result, items in the survey were included to elicit information relating to various situational variables and socio-demographic information. Situational variables included (amongst others): the purpose of the passenger's journey, the geographical origin of their surface access trip, whether they had started their journey from home, their place of work or elsewhere, how many bags they were carrying with them and the size of their travel party. Information about the number of flights the passenger had taken in the past 12 months was included, in addition to background information about general travel behaviour. Socio-demographic information relating to passenger age, nationality and residence was also collected. One item was included to determine willingness to share a ride to the airport with other passengers in the future. This item was designed specifically to link in with the evaluation of technologies for increasing ride sharing, which was discussed in the previous section. A small, but sizeable proportion, of respondents stated that they would be likely or very likely to choose to share a ride with a fellow passenger (not in their travel group) to get to the airport: 25% to share their own private car (if owned), 34% to share someone else's car, and 37% to share a taxi. Reasons put forward by respondents against sharing included unwillingness to share with a person not known to them (often due to personal safety) and a lack of convenience.

In conjunction with the various attitudinal data, this information was entered into a cluster analysis procedure in order to identify a set of homogenous market segments of respondents, based on their surface access behaviour, attitudes, situational characteristics and socio-demographic information. By establishing segments of passengers who share similar attitudes and characteristics, future policies can be targeted specifically to the groups where they are likely to stand the greatest chance of success.

Eight distinct groups were identified. These related to six groups who claimed to have regular access to a car in the UK, and two groups without car access. Each group is given a name based on the general attitudes and characteristics of the group. The two ‘non-car access’ groups were identified *a priori*, as access to a car inevitably heavily outweighs attitudinal or situational considerations when deciding how to travel to the airport. The eight groups are listed in Table 1, together with a very brief summary of each group’s general outlook.

*Table 1. A summary of the cluster profiles*

<b>Cluster</b>	<b>Car access</b>	<b>Description</b>
Devoted Drivers (21.2%)	Yes	Very positive attitude towards car use, feel social pressure to do so. Negative view of public transport.
Remorseless Motorists (17.6%)	Yes	Do not consider car access to airports to be a problem, and do not feel guilty about using their car.
Public Transport Avoiders (12.9%)	Yes	Not a particularly favourable attitude towards car use, but a very negative attitude towards public transport.
Frustrated Drivers (11.1%)	Yes	Aware of the impacts of car use, but feel that using public transport is too difficult for them and would not make much of a difference to the overall problem.
Drop-offs (10.9%)	Yes	Very positive attitude towards being dropped-off at the airport, perceive large barriers to using public transport.
Conscientious ‘greens’ (4.6%)	Yes	Keenly aware of the negative effects of car use, have a positive attitude towards public transport and feel under social pressure to use it.
Riders of necessity (16.4%)	No	Neither a positive or negative attitude to public transport nor a relatively weak intention to use it in the future. More positive attitude towards taxi use.
Car-less crusaders (5.3%)	No	Very strong positive attitude towards public transport, perceive few barriers to using it, and feel that their own actions can make a difference.

The results of the cluster analysis revealed a wide range of attitudes and perceptions in the survey. As expected the groups representing car users and people being dropped-off at the

airport represented the largest share of the sample. From a policy perspective it is important to target policies at groups where they are likely to stand the greatest chance of success. For example, policies to increase public transport use may be more effective when targeted at the 'Frustrated Drivers' group than the 'Devoted Drivers' group. The former are aware of the problem of car access to airports, but perceive large barriers to using public transport. In comparison, the 'Devoted Drivers' have a very positive attitude towards using their car coupled with a negative view of public transport. A possible focus of policy in this case, for example, could be to try and reduce the perceived barriers to using public transport by the 'Frustrated Drivers' group.

This also highlights an important point about travel behaviour and model choice, namely that people may act in the same way but for different reasons. For example, the 'Devoted Drivers' and 'Public Transport Avoiders' group both exhibit high private car use, but their reasons for this choice appear to be different. While the former have a positive attitude towards car use, and value the comfort and convenience it provides, the latter appear to choose to use their car because they actively dislike public transport, and want to avoid using it. This has important implications when formulating policy.

While significant attention is paid to increasing public transport use, it is equally important that strategies are implemented to ensure that there isn't mode shift in the 'wrong' direction. The 'Riders of Necessity' group, for example, exhibit a higher than average use of public transport. It would seem that this not because of their positive view of public transport, but a result of their lack of access to a car. Indeed, attitudes to taxi and drop-off are more favourable than public transport use for this group. From an environmental perspective it is important that there is not a significant shift towards taxi or drop-off use in this group, who represent the third largest segment in the analysis.

## **Discussion and conclusions**

Listing the surface access transport modes according to their environmental impact highlights the importance of the shift from motor car based trips to public transport. Initial investigation, incorporating the surface access transport mode 'pyramid' classification, has also shown the importance of distinguishing between 'double' trips (drop-off/pick-up and taxi) verses 'single' trips (car/pick up and minicab) to and from the airport. Using this framework to examine the sustainable development performance of surface access trips, the contribution of technology and behavioural intervention measures has been evaluated.

Although not the only solution, or a quick fix to the surface access problem, technology could have a role in reducing the carbon emissions generated from trips to and from airports, particularly when the focus is on airports in the year 2020. Telepresence represents a technology that could reduce the level of drop-off / pick-up trips to the airport, as market presence increases and the costs of installation and usage decrease. Perhaps the use of technologies to encourage car share could also reduce drop-off / pick-up journeys, the most carbon emission generating method of travelling to and from airports. The Manchester airport survey has shown that a small but sizeable proportion of passengers would be willing to car share. A separate technological solution, the use of RFID tagging, could help to overcome the difficulty of taking luggage on public transport to access airports.

The behavioural element to the surface access problem has been examined using psychological-based theories and models. The link between intention and use of public

transport has been confirmed; segmentation could be utilised to target particular population groups with the greatest propensity to use public transport, such as ‘Frustrated Drivers’ within the Manchester airport survey. It would not be effective to encourage individuals to use public transport for journeys to and from the airport using arguments relating to moral feeling of guilt or efficacy. Although much of the focus here has been on the modal shift from the motor car to public transport, it has to be acknowledged that passengers can move in the opposite direction (from public transport to the motor car), and airports need to be aware of this.

The insights generated from this study need to be placed in a wider context. Surface access transport journeys are dominated by motor car trips. Therefore, sustainable development gains are likely to be small in scale, and any improvements to the sustainable transport modal shares are likely to be only a few percentage points. That said, as highlighted in this paper, there are a range of potential solutions emerging from the different technological and behavioural disciplines.

These insights also need to be placed in an airport-related context. From the initial review it is evident that airports are not in control of all associated surface access operations, with a range of stakeholders with vested interests (e.g. public transport operators, third party tenants at the airport). In addition, as airports differ greatly in terms size and function, some of the solutions suggested here may not work in certain situations. For example, the technological solutions presented in this paper require an airport terminal of a sufficient size and passenger volume in order to be financially viable, and so may only work in the larger airports.

The work presented here will be developed to incorporate airport trips for employees and associated policy abatement methods such as car sharing schemes, working at home and incentives for using public transport. The research has also demonstrated (and as highlighted by Humphreys and Ison, 2005) that there is a further requirement to improve data collection at airports, such as the monitoring of emission targets in order to generate a clearer evidence base for emission improvements.

Returning to the over-arching theme of sustainable development, much of the emphasis within this paper has been on environmental improvements (e.g. through carbon emission reductions), and as such the findings should also be placed in an economic context. Given that airports tend to be financially vulnerable and that there are current recessionary pressures, many of the proposed solutions within the paper need to be set in a medium- to long-term timeframe, say for the year 2020 and beyond.

## References

Abrahamse, W., Steg, L., Gifford, R., and Vlek, C. (2009). Factors influencing car use for commuting and the intention to reduce it: A question of self-interest or morality? *Transportation Research Part F*, 12(4), 317-324.

Ajzen, I. (1991). The Theory of Planned Behaviour, *Organizational Behaviour and Human Process*, 50, 179-211

Anderson K, Bows A, and Footitt. A. (2007). Aviation in a low carbon EU. A research report by the Tyndall Centre, University of Manchester. Friends of the Earth. [[http://www.foe.co.uk/resource/reports/aviation\\_tyndall\\_07\\_main.pdf](http://www.foe.co.uk/resource/reports/aviation_tyndall_07_main.pdf), accessed 24-05-2012].

- Bamberg, S., Fujii, S., Friman, M., and Gärling, T. (2011). Behaviour theory and soft transport policy options, *Transport Policy*, 18(1), 228-235
- Bamberg, S., Hunecke, M., and Blöbaum, A. (2007). Social context, personal norms and the use of public transportation: Two field studies, *Journal of Environmental Psychology*, 27(3), 190-203.
- Brilha, N.M. (2008). Airport Requirements for Leisure Travellers, in Graham, A., Papatheodorou, A. and Forsyth, P. *Aviation and Tourism: Implications for Leisure Travel* (Eds.), 167-177, London, Ashgate.
- Budd, T.M.J., Ison, S.G and Ryley, T.J. (2011a). Airport Surface Access Management: Issues and Policies. *Journal of Airport Management*, 6 (1), 80-97.
- Budd, T.M.J., Ison, S.G and Ryley, T.J. (2011b). Airport Surface Access in the UK: a management perspective. *Research in Transportation Business and Management*, 1, 100-117.
- Civil Aviation Authority (2012). UK Airport Statistics 2011. [<http://www.caa.co.uk/default.aspx?catid=80&pagetype=88&sglid=3&fld=2011Annual>], accessed 24-05-2012]
- Department for Environment, Food and Rural Affairs. (2005) *Securing the Future - UK Government sustainable development strategy*. HMSO, London. [<http://archive.defra.gov.uk/sustainable/government/publications/uk-strategy/>], accessed 24-05-2012]
- Department for Environment, Food and Rural Affairs. (2008) *Climate Change Bill*. HMSO, London.
- Department for Transport. (2004) *Aviation and Global Warming*. Department for Transport. [<http://www.dft.gov.uk/about/strategy/whitepapers/air/docs/aviationglobalwarmingreport.pdf>], accessed 24-05-2012].
- Dresner, M. (2006). Leisure versus business passengers: Similarities, differences, and implications, *Journal of Air Transport Management*, 12(1), 28-32.
- Future Travel Experience (2012). Offsite agents to improve passenger service levels, 3<sup>rd</sup> May, 2012. [<http://www.futuretravelexperience.com/2012/05/offsite-agents-to-improve-passenger-service-levels/>], accessed 24-05-2012]
- Hess, S. and Polak, J. W. (2006). Exploring the potential for cross-nesting structures in airport-choice analysis: a case study of the Greater London Area. *Transportation Research Part E*, 42, 63-81
- Humphreys, I., and Ison, S. (2005). Changing airport employee travel behaviour: the role of airport surface access strategies, *Transport Policy*, 12 (1), 1-9.
- Koster, P., Kroes, E. and Verhoef, E. (2011). Travel time variability and airport accessibility. *Transportation Research Part B*, 45(10), 1545-1559.

Leigh Fisher Associates, Coogan, M and MarketSense Consulting. (2000). Improving Public Transportation Access to Large Airports, TCRP (Transit Cooperative Research Program) Report 62, Transportation Research Board of the National Academies, Washington, D.C.

Pels, E., Nijkamp, P. and Rietveld, P. (2003). Access to and competition between airports: a case study for the San Francisco Bay Area, *Transportation Research Part A*, 37(1), 71-83.

Schwartz, S. H. (1977). Normative influences on altruism. In L. Berkowitz (Eds.), *Advances in experimental social psychology*, 10, 221-279. New York: Academic Press.

Vespermann, J. and Wald, A. (2011). Intermodal integration in air transportation: status quo, motives and future developments. *Journal of Transport Geography*, 19, 1187-1197.



**Modal Integrating Bus Rapid Transit (BRT) Systems with Cycle-rickshaws in Developing Cities: A case study on Dhaka City, Bangladesh**

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**Abstract**

Various types of non-motorized modes and para-transits or informal modes are playing a crucial role of transport in many developing cities. Rickshaws, for instance, are available as a travel mode in many countries, particularly in Asia. Few researchers argue that instead of restricting, if planned properly, rickshaws could play an important role of feeder service or access leg to formal public transport. Better integration of various modes could provide convenience and comfort to the public transport users and thus increase ridership on public transport. Several modern BRT systems (i.e. Bogota, Guangzhou) have been integrated with bicycles; however, there is no BRT system in the world which yet demonstrates integration with rickshaws.

This paper explores if the rickshaws can serve as a feeder service of BRT systems and what type of design for BRT station could assist for modal integration to provide easy, convenient, fast and safe transfer between rickshaws and BRT systems. Empirical approach was followed with the case study on Dhaka City to fulfill the research purpose.

An effective participation of the stakeholder groups was ensured with the aim of ‘transport within lifestyle’ solutions for designing the BRT station area. The methods involved three steps of work: preparing the initial plan, understanding the stakeholder’s view about the initial plan, and re-designing the plan considering the stakeholder’s opinion. The research is on-going, yet to be prepared the final plan with incorporating the stakeholder’s views. It is expected that the final plan would provide design of BRT station for modal integration with rickshaws where the rickshaws could serve as a feeder service in the secondary and/or narrow roads and the modal changes between rickshaws and BRT for the passengers would be easy, convenient, fast and safe.

**1. Introduction**

Public transport modes serve the majority of the trips in developing cities. For instance, road-based public transport serves 42% of trips in Delhi (Tiwari, 2003) and 44% of trips in Dhaka (STP, 2005). This is happening because till a significant numbers of people are poor, who can not afford personal vehicle, and most of them are heavily dependent on public transport. However, the service level of public transport is very poor and often remains overcrowded. Moreover, the formal regular public transport do not serve the whole city or can not serve all parts and not able to meet the travel demand of all strata of people. A variety of informal mode (IMs) or non-motorized transport (NMTs) and para-transits have evolved in many cities to fill up the gap between demand and supply of public transport services. Such as, (cycle)-rickshaws and auto in Bangladesh and India, pedicab and habalhabal in the Philippines, becak and ojeg in Indonesia, tuktuk in Thailand, and so on. These informal

modes are playing an important role of transport and accessibility in many cities. They are demand responsive and mostly serve for shorter distance.

A large number of rickshaws are available as a travel mode in many cities, particularly in Asia. The rickshaws often provide transport access to certain areas, particularly in the narrow streets where formal public transport is not accessible, and for certain group of people (i.e. female or senior people) who have difficulties of access in to the overcrowded public transport. Rickshaws are fuel-free (environment friendly) mode and only available public transport when roads are inundated due to heavy rain or flood in urban areas. This sector absorbs a large number of unskilled and/or illiterate labor forces migrating from rural areas. Many cities (i.e. Jakarta, Beijing, Bangkok, Manila, Delhi, Kolkata, Karachi, Dhaka, and many more) have tried to restrain rickshaws either for reducing congestion (smooth flow of motorized traffic) or enhance the city image by eliminating traditional modes from the entire city or certain roads. There is evidence that the cities that have restrained rickshaws have not been able to attain the purpose of smooth flow of motorized traffic or to get rid of congestions (Gallagher, 1992). After banning rickshaws in major arterials of Dhaka, average travel time as well as overall travel cost for passengers on those arterials has increased (Barakat, 2004). This is because the rickshaws are forced to make lengthy diversions onto the narrow roads. Furthermore, passengers are taking rickshaw trips as there is no alternative public transport service available. Even after many years of 'elimination', thousands of rickshaws still operate in the suburbs and local roads of Jakarta and Manila. These indicate that the rickshaw ban is controversial.

There are arguments that in the era of global warming, the transports resilient to climate changes need to be promoted for sustainability. NMT received much attention of transport research since the adverse impacts of climate changes have been realized. In line with this, it is argued that the rickshaws should be promoted. However, rickshaw cannot always be readily replaced by motorized vehicles (Replogle, 1991). Possibly for two reasons it cannot be replaced. First, rickshaws would not be an alternative of the public transport trips as they are used mainly for shorter distance trips. For instance, average distance for rickshaw trips in Dhaka is only 2.34 km (STP, 2005) and in Delhi is below 3 km (ITDP, 2009). Second, different order or hierarchy of roads has different level of functions; and a particular road type may have priority for a different vehicle class to have the greater social benefits. For instance, in the busy major arterials fast-moving mass transit systems may get priority whilst in narrow streets of the neighborhood may need slow-moving flexible mode like rickshaws. There is argument that instead of restricting, if planned properly rickshaws might able providing feeder service to the public transport.

Cities in the developing countries are growing and expanding outwards due to rapid urbanization. With the expansion of city as well as complicated nature of trips, the combination of different travel modes between trip ends represents the new reality (Pitsiava-Latinopoulou, et al. 2008). A trip on public transport involves a transfer as the trip maker has to walk to/from station. The public transport interchanges (PTIs) or change of travel modes are increasing and becoming common in the larger cities. However, the PTIs are often dull and unsafe for the passengers or pedestrians (Verster, 2005); and the passengers have to walk a long distance in developing cities. To have efficient and comfortable journey of public transport users, the interchange areas for changing between modes should be convenient, fast, and safe. The interconnection of different modes seems to have easy solutions, but its implementation involves complex details of accessibility and urban space management

(Burckhart and Blair, 2009). Interconnection with NMT is more difficult as it requires different planning and design requirements.

## **2. Objectives**

Many cities both in the global North and South have implemented Bus Rapid Transit (BRT) systems as a mass transit, while others are planning to do so as a means of improved public transport and tackling the increasing transport problems. Effectiveness of BRT depends on presence of complementary transport options such as promotion of NMT and integrated feeder service, planning and design based in real-world conditions, and strict enforcement (Matsumoto, 2007). This is because feeder services are crucial to maximize the benefits of mass transit systems. A few researchers argued that rickshaws might be an option to fill the future need of feeder services to the mass transit systems in Dhaka city as well as in other cities. Several modern BRT systems (i.e. Bogota, Guangzhou) have done modal integration with bicycles; however, there is no BRT system in the world which yet demonstrates integration with rickshaws.

Transport integration could be of various types (see May and Roberts, 1995; Potter and Skinner, 2000). Modal integration deals with easy transfer between different modes through their close physical location and/or integrated time-table planning whilst fare integration deals with ticketing arrangements. Most of the research on multi-modal urban transport or integrated transport is with the case study on cities of developed countries and focused on macro-scale. Majority of them showed what or how was done and what could be done for integration; but do not give any specific plan or design considering the local socio-economic condition and travel behaviour or traffic characteristics. Detailed study at micro-level in the developing cities, particularly with variety of NMT or IMs and poor lane discipline among the road users, is still missing.

The purpose of this paper is to explore whether instead of restricting the rickshaws could be planned for serving as an access leg of mass transit systems in the developing cities. The main objective of the paper is to show: (i) if the rickshaws could serve as a feeder service of BRT systems in Dhaka city; and (ii) what type of physical design for BRT station could assist for such by ensuring easy transfer between rickshaws and BRT through their close physical location.

## **3. Description of the Study Area**

Dhaka, the capital city of Bangladesh, is known as the city of rickshaw. There are about 600,000 rickshaws are available in Dhaka for hire as a taxi-type service. Dhaka is one of the fastest growing and highly dense cities of the world. The city is of about 1,529 sq km land area and contains about 10 million people (in 2004) which is projected to be 14.1 million by year 2014 and 19.8 million by year 2024 (STP, 2005). Per capita income of the city is only US\$ 608.

The transportation systems of Dhaka City is predominantly road based. Dhaka is one of the least motorized cities in the world with approximately 32 motorized vehicles per 1,000 people. However, the growth of personal vehicle is increasing very rapidly. Because of inadequate and disorganized bus service, rickshaws become popular mode among the middle and lower-middle income groups. Modal share of trips in Dhaka are 44% on bus, 34% on rickshaws, 8% on personal vehicles, and 14% walking (STP, 2005). Pedestrian volumes of

10,000 to 20,000 per day are common and reach as high as 30,000 to 50,000 per day in the Old City area.

Six mass rapid transit routes (3 Metro and 3 BRT) of total length about 76 km have been proposed in the Strategic Transport Plan (STP) for Dhaka City (STP, 2005). Proposed BRT routes are: *Uttara to Saidabad* (BRT Line 1), *Gabtali to Saidabad* (BRT Line 2), and *Airport to Old Dhaka* (BRT Line 3). Proposed Metro routes are: *Uttara to Saidabad* (Metro Line 4), *Gulshan to Dhanmondi* (Metro Line 5), and *Pallabi to Saidabad* (Metro Line 6). Feasibility study of a BRT route (BRT Line 1) and a Metro route (Metro Line 6) is on-going now. As there is no BRT system yet in Dhaka, locations of prospective station area (existing public transport stops or major road intersections) had been considered for the detailed study. Two locations had been studied are *Kakoli* (referred as Location A) and *Sayedabad* (referred as Location B).

### **Location A: *Kakoli***

Kakoli is located on Mohakhali-Airport corridor. This corridor is rickshaw-free and connecting the northern part of the country with the capital city. Well-planned and high-income residential areas (with higher car ownership rate) such as Gulshan, Banani, Nikunja, and Uttara are situated beside this corridor and close to Kakoli. Right of way (ROW) of the corridor at Kakoli point is about 95-100 feet (and additional 24-32 feet in bus bay area) and providing four lanes in both directions. There is a very busy existing bus station and a small train station at Kakoli. BRT Line 3 proposed in STP passes through Kakoli.



**Figure 1: Photograph of *Kakoli* Intersection- Location A (left); *Sayedabad* Intersection- Location B (right)**

### **Location B: *Sayedabad***

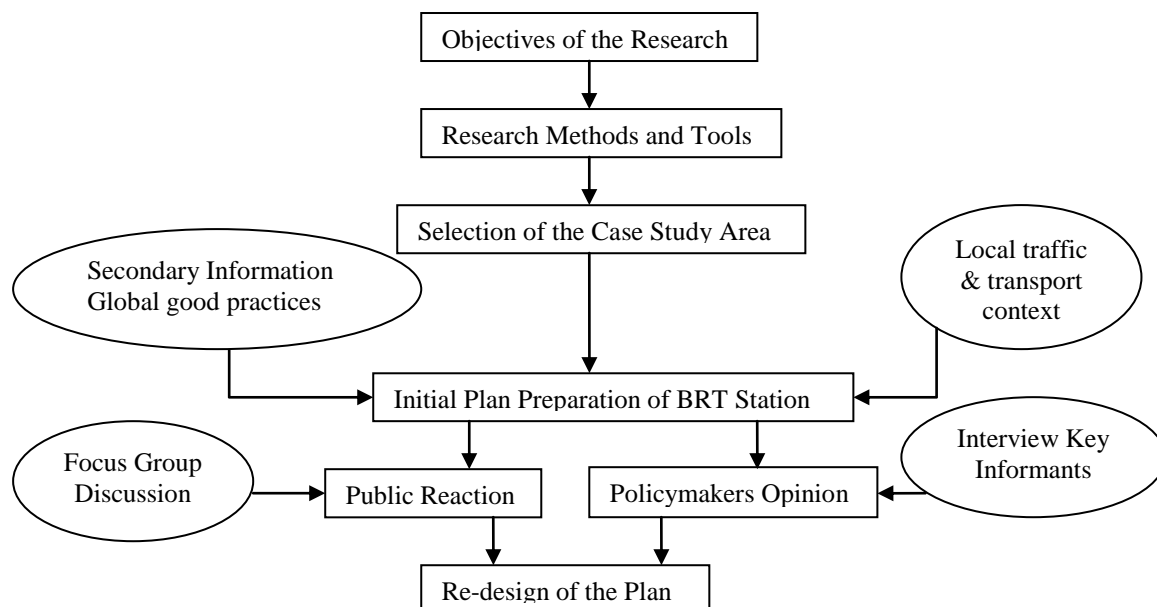
Sayedabad is located on Gulistan-Sayedabad corridor. This corridor is connecting the southern part of the country with the capital city. Mixed traffic (including rickshaws and other NMTs) are plying in this corridor. Surrounding areas of Syabed are mostly residential areas of low-income and middle-income groups developed spontaneously or unplanned manner. ROW of this corridor at Sayedabad point is about 90 feet (variable, 100 feet in few points) and providing three lanes in both directions. Construction of a flyover (Gulistan-Jatrabari) is going on and expected to be completed by 2013. If flyover is in place, middle portion of road for a width of about 14 feet throughout the corridor will not be usable for traffic because of the pillars' of flyover. One of the largest inter-city bus terminals of the city is located at Sayedabad. BRT Line 1 and BRT Line 2 proposed in STP terminate at Sayedabad.

#### 4. Methods Used

Management of transport problem, particularly for NMT, is not a purely technical matter. Moreover, often either the user's opinion/behavior is not considered or requirements of few modes (i.e. NMTs or IMs) are just ignored while designing/planning the public transport station in developing cities. Hence, the participatory methods and qualitative approach had been used to fulfill the research objectives and achieving social sustainability through 'transport within lifestyle' solutions. Participatory methods provide opportunity for inclusion of the voice of weaker (i.e. rickshaw pullers or pedestrian) groups whilst the qualitative approach considers soft factors or behavioral aspects of the transport users at specific context.

The research involved three steps of work (Figure 2):

- (i) preparing initial plan of BRT station based on existing literature and good practices of BRT operating globally;
- (ii) involvement of stakeholder's and policymaker's in designing the BRT station through understanding their views and opinions; and
- (iii) preparing the final plan of BRT station for integrating with rickshaws considering the stakeholder's opinion.



**Figure 2: Flow-chart of the Methods (Major Tasks and Activities)**

#### 4.1. Preparing the Initial Plan

Based on the review of literature and good practices of BRT systems as well as the local context (road width and traffic), an initial plan for both locations (A and B) was prepared (Figure 3 and Figure 4). It was considered that the BRT would be ‘closed system’ as the BRT operating in Bogota and Curitiba; and will provide trunk-feeder services.

Designing the BRT station depends on the decision options of BRT systems as well as space availability in that particular location. The median option to locate the bus-way is the most common for successful BRTs globally. This reduces the turning conflicts and allows a central station to serve both directions of BRT (Wright and Hook, 2007). Having frequent connections of roads to the major corridor and frequent left-turn vehicles, it would be better to have median station in Dhaka. However, the station could be staggered (split with a different station serving each direction of travel) or elongated to overcome the spatial constraints or limited road width of station areas.

##### Location A - *Kakoli*

Considering the limited ROW but availability of two bus-bays at *Kakoli*, staggered two stations (each for different direction of bus-way) was considered. Station for outbound will be 20m long to serve one bi-articulated bus whilst the station for inbound will be about 80-100m long to accommodate two bi-articulated buses at a time (Figure 3). In each station, pedestrian crossing to access the BRT station was given at grade, both sides of the station, as well as overpass through ramps. One lane in each direction was given for BRT (with overtaking facilities at station) and the remaining three lanes per direction were kept for other traffic. Space for rickshaws (waiting area to get passengers and alighting passengers) were provided in four connecting roads and it was estimated that modal interchange between rickshaws and BRT will involve no more than 150 m of walking (or less than 3 minutes of walk) for the passengers. Considering the high pedestrian flow, the width of footpaths was considered for 12 feet.

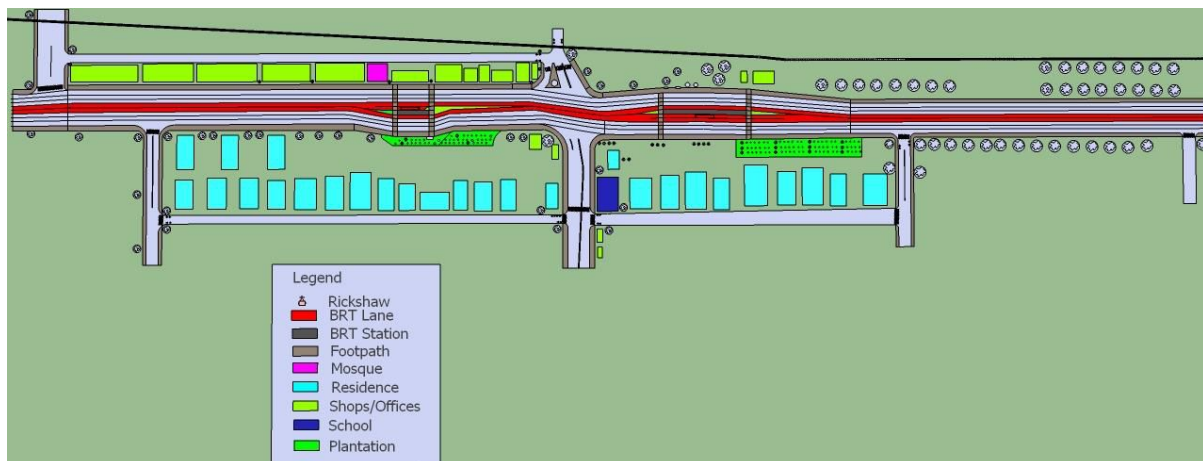
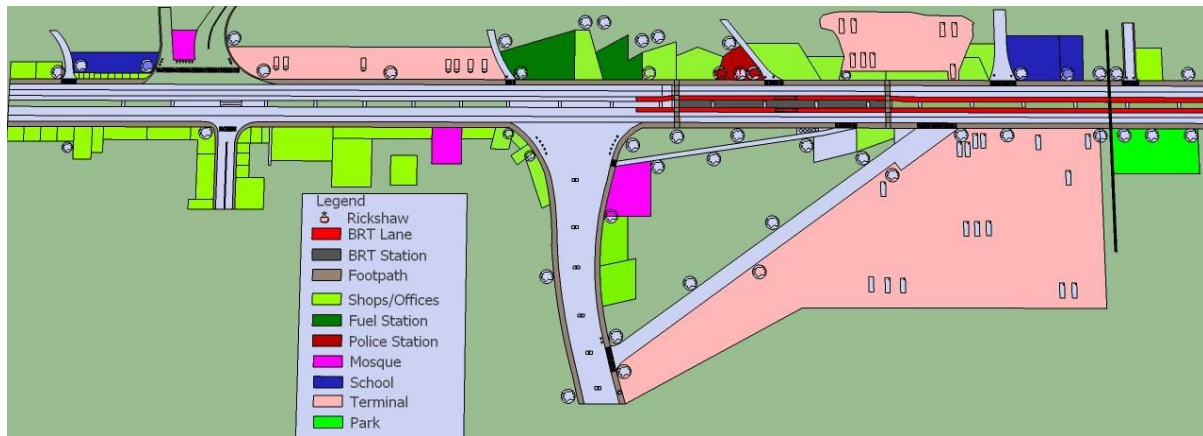


Figure 3: Initial Plan of BRT Station at Location A (*Kakoli* Area)

##### Location B – *Sayedbad*

Due to the limited ROW, an elongated (bit longer) station was considered for *Sayedbad* area. One elongated station to serve for both direction of bus-way was considered as it would be possible to accommodate two bi-articulated buses at a time (Figure 4). No overtaking for

BRT at station was considered as it is the terminating (or starting) point of BRT system. One lane in each direction for BRT was given and the remaining two lanes per direction were kept for other mixed traffic. Pedestrian crossing to access the BRT station was given at grade in both sides of the station. Space for rickshaws (for waiting to catch passengers and alighting passengers) were provided in all the connecting branch roads and it was estimated that modal interchange between rickshaws and BRT will involve maximum 200 m of walking (or 4 to 5 minutes of walk) for the passengers. Considering the existing inter-district bus terminal and possibility of high pedestrian flow, the width of footpaths was considered for 12 feet.



**Figure 4: Initial Plan of BRT Station at Location B (Sayedabad Area)**

#### **4.2. Involvement of Stakeholders' and Policymakers'**

Various methods of participation are available in literature to incorporate the views of public into a decision-making process. These could vary from a simple transmission of information to a complex negotiation. Focus groups are frequently used in participatory research. Participatory action research (PAR) aims to engage key stakeholders as participants in the design and conduct of the research (Fossey, et al. 2002).

Deliberative methods, FGDs in a form of PAR, had been applied to explore stakeholders' view and interview of the key informants was used to incorporate their opinion and views in the planning of BRT station area. Exploring the stakeholders' view about the design of BRT station involves two major issues. *Firstly*, issues related with stakeholder group (i.e. identifying the stakeholders, group size and group dynamics, venue, session, and administration); and *Secondly*, how to present the plan to the stakeholders during the discussion/meeting. Conducting the key informants' interview involved issues related with the size of sample, selection and recruiting the sample, etc. Following sections elaborate the process how the issues were considered.

##### ***Stakeholder Groups for FGD***

Most researchers recommend for homogeneity within each group or people with similar characteristics to a single session (Krueger and Casey, 2000; Kitzinger, 1995). Even though the data could be enhanced by group dynamics, the groups were kept homogenous for a single session to ensure active participation of all members during the discussion.

Considering the research purpose, the passengers of both the public transport and rickshaw as well as the 'rickshaw-pullers' would be the key stakeholders. Being the provision of transport



facilities is highly gendered and often the voices of women are not listened in a mixed-group (Turner and Grieco, 2006; Turner and Fouracre, 1995); groups of ‘women only’ and ‘men only’ were formed. However, this should be noted that all the members of rickshaw-puller group were male, as there is no female rickshaw-puller. Researches on transport reveal that there is difference in travel pattern as well as use of travel modes with the difference of household income. Hence, both the ‘middle-income’ and ‘poor-income’ people of the passengers were considered in separate groups. Disabled people may have particular needs in public transport usage, so a separate group was formed for them. However, ‘disabled-group’ was not location specific and ‘men-only’ or ‘women-only’ – gender balanced only a single group of disabled people was formed to study the both locations. Thus, the total number of FGDs with different stakeholder groups for two study locations was 11 (Table 1).

**Table 1: Category of the Groups and Numbers of FGDs**

Category of the Groups	Number of FGDs	
	Location A	Location B
Middle-income group male-only	FGD 1	FGD 6
Middle-income group female-only	FGD 2	FGD 7
Poor-income group male-only	FGD 3	FGD 8
Poor-income group female-only	FGD 4	FGD 9
Rickshaw pullers	FGD 5	FGD 10
Disabled (gender balanced)	FGD 11	

While recruiting the members for each group it was ensured that they have knowledge about the case study location and uses the area in regular basis or live within 1 km of the area. There were 5 to 8 people in each group. It was insured that in each group the members represents different age groups as well as education or employment. Except the disabled, in each user groups had a student, elderly person, job/service, teacher, job seeker, housewife (only for ‘women-only’ groups), and business. The discussion was made in local language and the whole session was recorded in video tapes. Discussion of each group was for about 90 minutes.

### ***Presenting the Initial Plan during FGD***

The major challenging task for the FGDs was how to present the initial plan of BRT station among the stakeholders’ for their easy understanding and participation in the discussion. A large map (2D) was used for showing the city and the detail land use of case study locations. Photographs of the case study location and good practices of BRT operating in other developing countries were shown. Then, a simple 2-D map (top view) as well as a 3-D model (made with board and hard paper) of the BRT station area were shown for easy understanding of the general (non-technical) people and kept the 3-D model in front of them for the whole duration of group discussion.





**Figure 5: Model (3-D) Initial Plan of Kakoli- Location A (left); Sayedabad- Location B (right)**

### ***Policymaker's Involvement***

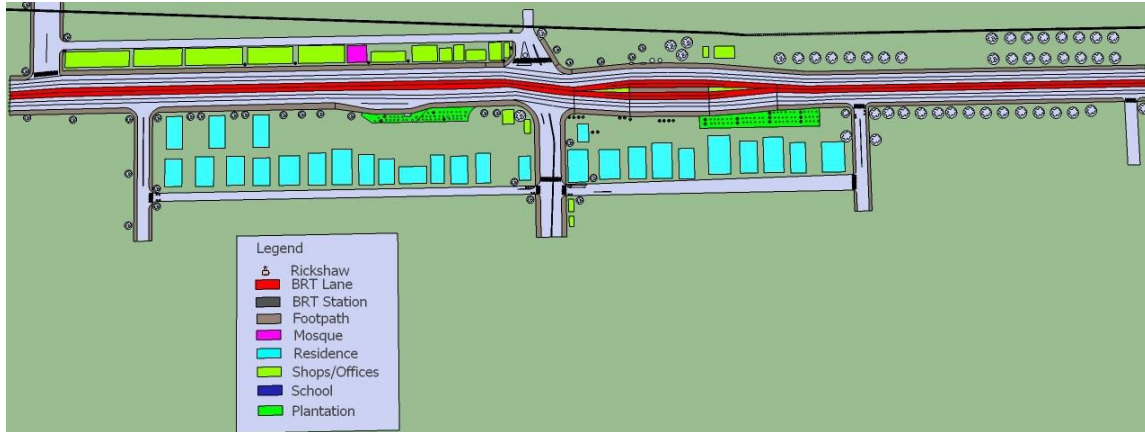
Face-to-face interview of 25 transport professionals/policymakers had been conducted based on a semi-structured open-ended questionnaire. Key informants interview can be used for an expert validation of findings (Flick, 2006); which often complement to other methods or provide additional information. Maps of the case study area, initial plan of BRT station, and photographs of study area as well as BRT in other countries were shown in a PowerPoint presentation using a laptop during the discussion. Each interview lasted for about 40 minutes and had been recorded in a audio-recording device. Interview included the following personals:

- Project Manager of the proposed BRT
- Consultant of the proposed BRT
- Director of the DTCB (Dhaka Transport Coordination Board)
- Urban Planner of the city development authority (RAJUK)
- Urban Planner of DCC (Dhaka City Corporation)
- Enforcement Officer of BRTA (Bangladesh Road Transport Authority)
- Transport Planner of RHD (Roads and Highways Department)
- Division Head or Representative from the Ministry of Transport
- Sr. Traffic Police Official of DMP (Dhaka Metropolitan Police)
- Inspector or Field Officer of DMP
- University Professors: Urban Planning, Transport Planning, Civil Engineering
- Civil Society Representative or Social Worker / Development Activist
- Elected Public representatives: Ward Commissioner and Parliament Member

## **5. Results and Significance of the Paper**

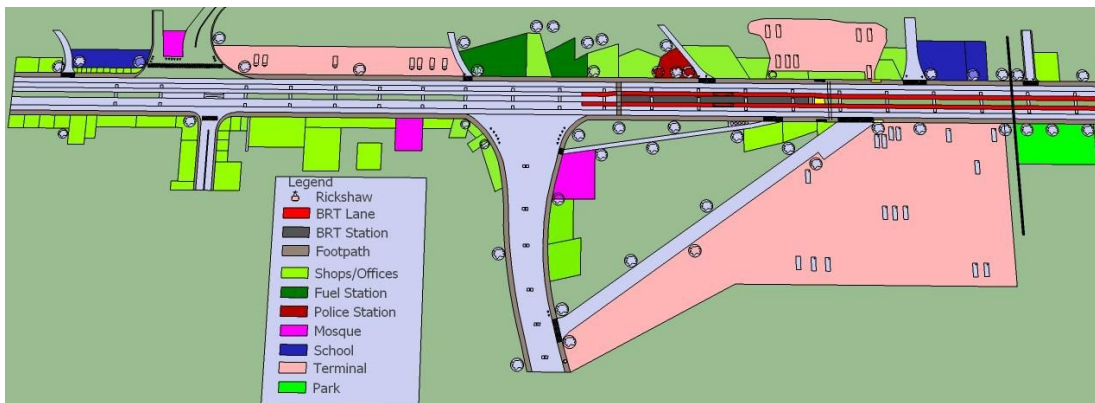
The research is on-going; just finished conducting the FGDs and interviews of the key informants but yet to analyze those and redesign the plan. After consultation with the stakeholders and key informants, the initial plan will be modified and re-designed considering their opinion and suggestions. Nevertheless, the paper reports the initial findings of designing BRT station for the two study locations.

Instead of two staggered stations one single station should be provided at *Kakoli* area. This is because staggered stations will involve more cost for construction as well as more time and effort of walking for the passengers. Considering the traffic nature of the corridor (mostly high speed motorized vehicles) and safety issues of the pedestrians, mostly mentioned to have either overpass or underpass instead of 'at grade' crossing. However, the disabled people mentioned always they want only the 'at grade' crossing because the ramps of underpass or overpass are very tiring and it requires tremendous energy for them to cross. Rickshaw waiting area should be properly maintained in a queue. Almost all the participants mentioned to have more natural shade (trees) for their comfort while walking.



**Figure 6: Tentative Final Plan of BRT Station at Location A (*Kakoli Area*)**

There were not much changes or modification for the BRT station design prepared for *Sayedabd*. Pedestrian crossing to access in BRT station was mentioned to have underground in one side (close to the bus terminal) and at grade to other side (close to the T-junction). Almost everybody mentioned to have more natural shade (trees) for the comfort of pedestrians.



**Figure 7: Tentative Final Plan of BRT Station at Location B (*Sayedbad Area*)**

## 6. Conclusions

Participation from an early stage of planning and implementation process through engaging effectively with the knowledge, value and interests of stakeholders and wider society enables sustainability of the transport projects or a wider acceptance among the stakeholders. This paper provides learning for public involvement and stakeholder's opinion in transport decision-making process. It contributes in developing a methodology for effective participation in designing BRT station area (for accommodating rickshaws to ensure multi-modal transport system). From the policy perspective, the approach outlined in this paper could be applied in other developing cities for involving stakeholders' in planning and designing of transport infrastructure. The approach could be helpful for further research on accommodating other para-transit or informal modes in BRT station.

The rickshaws are already playing an important role of transport in Dhaka City. It is providing transport services for the short trips as well as feeder services to the public

transport. Often the rickshaws provide transport access to the narrow streets where the motorized vehicles are not accessible or formal public transport services are not available. Rastogi and Rao (2003) explored mostly NMT or para-transit is used as a feeder service of the transit system in Mumbai, India. Being the formal public transport is overcrowded, rickshaws become popular among the elderly or women or disabled people in Dhaka, Bangladesh. BRT cannot bring success as a stand-alone policy. As Matsumoto (2007) claimed effectiveness of BRT depends on presence of complementary transport options such as promotion of NMT and integrated feeder service, planning and design based in real-world conditions, and strict enforcement. There are potentials that rickshaws would be able to serve as a feeder services for BRT systems. Instead of restricting, if planned properly, rickshaws could play an important role as a feeder service or access leg of public transport. However, a careful planning and design for rickshaws is needed to be served as access leg. It is expected that the final design of BRT station derived from the analysis of stakeholders' and key informants' opinion to integrate BRT with rickshaws will provide easy, convenient, comfortable, and safer transfers of passengers between rickshaw and BRT.

However, the rickshaw needs some prerequisites to provide feeder services of BRT systems. They have to be well-organized and well behaved (with the customers) at the waiting area close to the BRT station. Without fare integration, there would not be the ultimate benefits or convenience of the users. Usually the fare of rickshaw is determined through a bargaining process between the rickshaw uses and puller before the trip is initiated. As rickshaw has no specific fixed route and it is also not readily available to measure the distance for each trip, it would be a challenging task to have a pre-determined and fixed fare for it. Unless a pre-determined fare structure is possible to establish for rickshaws, it would not be possible to make the fare integration. Hence, the further research could be how to determine pre-determined fixed fare for rickshaw trips and the further possibility of fare integration between rickshaws and BRT systems. Further research could also be modeling or simulation of the final plan prepared for BRT station and transferability of the plan in to other similar cities.

## 7. References

- Barkat, A; Karim, W.; Sarker, A. H.; Hoque, S.; Poddar, A. 2004. *After study on the impact of Mirpur demonstration corridor project (Gabtoli-Russel Square)*, Human development research centre (HDRC), Prepared for DTCB.
- Burckhart, K. and Blair, C. 2009. "Urban intermodality: potentials for connecting the cities' public transport", *Urban Transport XV - Urban transport and the environment*, 107.
- Flick, U. (2009). *An Introduction to Qualitative Research*. London: SAGE Publications.
- Fossey, E.; Harvey, C.; McDermott, F. and Davidson, L. 2002. Understanding and evaluating qualitative research", *Australian and New Zeland Journal of Psychiatry*, 36, pp. 717 - 732.
- Gallagher, R. 1992. *The rickshaws of Bangladesh*. Dhaka: UPL.
- ITDP. (2009) Best Practices on Regulation and Design for Motorized and Non-Motorized Two and Three-Wheelers in Urban Traffic.
- Kitzinger, J. (1995). Qualitative Research: Introducing focus groups, Education and debate, *BMJ*, 311(700), pp. 299. Available at: <http://www.bmj.com/content/311/7000/299.full> (Retrieved on 22 December 2010).

- Krueger, R. A., and Casey, M. A. (2000). *Focus groups: A Practical Guide for Applied Research* (3<sup>rd</sup> edition.) Thousand Oaks, Calif: Sage.
- May, A. D. and Roberts, M. 1995. "The design of integrated transport strategies", *Transport Policy*, 2(2), pp. 97 - 105.
- Matsumoto, N. 2007. "Analysis of policy process to introduce bus rapid transit systems in Asian cities from the perspective of lesson-drawing: cases of Jakarta, Seoul, and Beijing", *Air pollution control in the transportation sector: third phase research report of the urban environmental management project*, Institute for global environmental strategies (IGES), pp. 351 - 375.
- Pitsiava-Latinopoulou, M. ; Zacharaki, E. et al. 2008. "Passenger intermodal terminal stations: role and infrastructure", in C. A. Brebbia (Ed.), *Urban Transport XIV - urban transport and the environment in the 21st century*, 101, pp. 233-242.
- Potter, S. and M. J. Skinner (2000) On Transport Integration: A Contribution to Better Understanding. *Futures*, 32, pp. 275-287.
- Rastogi, R. and Rao, K. V. K. 2003. "Travel characteristics of commuters accessing transit: case study", *Journal of transportation engineering*, 129(6), pp. 684-694.
- Replogle, M. (1991) Non-motorized Vehicles in Asia: Lessons for Sustainable Transport Planning and Policy. Non-Motorized Vehicles in Asian Cities, World Bank Technical Report 162, Environmental Defence Fund, Available at: [http://www.edf.org/documents/2293\\_NonmotorizedVehiclesAsia.pdf](http://www.edf.org/documents/2293_NonmotorizedVehiclesAsia.pdf) (Retrieved on 22 April 2011).
- STP. 2005. *Urban transport policy: The strategic transport plan (STP) for Dhaka*. Bangladesh Consultants Ltd (BCL) and Louis Berger Group Inc. Dhaka.
- Tiwari, G. 2003. "Transport and land-use policies in Delhi", *Bulletin of the world health organization: special theme-health impact assessment*, 81(6), pp. 444-450.
- Turner, J. and Grieco, M. 2006. "Gender and user group protocols: the need for new transport planning practices", *Urbanism and gender - a necessary vision for all*, Institut d'Edicions de la Diputació de Barcelona, pp. 53 - 68.
- Turner, J. and Fouracre, P. 1995. "Women and transport in developing countries", *Transport Reviews*, 15(1), pp. 77- 96.
- Verster, B. 2005. "Can public transport interchanges be positive urban environments in the developing world context?", in A. Kungolos, C. A. Brebbia and E. Beriatos (Ed) *Sustainable development and planning II, 1 & 2*, 84, pp. 941-949.

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ORAL PRESENTATION

track 5c - Regional sustainability: economic development and industrial symbiosis

### Cross analysis of theory (Systemic Design) and practice (case studies) to design and test framework for Local Economic Development

#### Abstract

**Local Economic Development** has significance within the cultural context in which it operates and is currently becoming an increasingly important part in international cooperation. In the last decade, the possibility to enable scenarios of bottom-up economic and social development, led by local actors, is gaining ground in the last decade. In this context of steady change, the national and local governments, like businesses and other organizations must rethink development strategies in order to lead the change to widespread prosperity of the people and the ecosystem. To reach these goals the implementation of an approach that goes beyond a specific and punctual solutions is needed, so it tends to create **connections between local material, energetic and informational resources, generating multiple and complex solutions**. In particular, **energy** is a *common good*, considered as fundamental need and shared by the society, but also it is an *individual right* to increase our own capability. The energy affects the lives of individuals and their various combinations: the environmental impact of businesses is largely determined by external and internal exchanges of resources. In Systems Theory, the economic, social and environmental benefits are required through the efficiency of flows. The local energy guarantees autonomy and derives mainly from renewable sources (biomass, ...) or perpetual (sun, water, ...) sources.

To corroborate the proposed thesis, the **research methodology** used to reach that goal is based on the combination of theory and practice that resolves in a **cross analysis**. The **theory of Systemic Design** and the **practice of Case studies** are tackled with the same keys: what, why, when, where and how. **The analysis of complex systems by scientific means** with societal relevance supports decision making, that approach turns environmental problems into business opportunities, so companies can transform unwanted waste and by-products into valuable products. **Eight case studies** have been chosen for their **approach, size, and experiences**. The selection of case studies is based on the production of green energy, the complex relations with more or less large networks of

companies, the compliance with the Systemic Design principles, above all the tendency to zero emissions. The different size of plants allows understand the regional effects with macro systems and the local effects with micro systems. In that way, the limits in using local resources to produce energy become evident. The localization of the cases is divided in two specific country of Europe: Sweden and Italy. The first country was chosen for its long experience in bioenergy and because its approach to that field is more holistic than other experienced countries. The second country has been chosen because of its strong theory in Systemic Design and because of supporter feeling to help that country to reach the European targets in the production of energy from renewable resources.

A **cross analysis** of the case studies and of the theoretical/practical parts is crucial to find the main results for designing the framework. That analysis aims to turn the theoretical knowledge into pathways of change suitable to the needs and capacities specific to regions or localities, and to replicate this model of territorial energy nets.

Rather than setting out with a proven “one-fits-all” solution in hand to catalyse the development of Systemic Design networks, this research primarily focuses on continuously fine-tuning and approach so as to make it best suited to dynamic region specific contexts.

In conclusion, the adoption of more **systemic production and person-centered approaches**, holds great potentiality to create **Local Economical Development**. The linkages between materials, energy, people and their knowledge are mapped out clearly, to design efficient path towards sustainable ways to use and re-use untapped resources. Using these territorial nets, we can collectively innovate to create energy systems that are beneficial for the people the environment, and pleasurable for all. In the field of renewable energy the creation of **sustainable infrastructures and agile energy systems could help the development of territories**. Furthermore, the designed framework is tested in a micro-system (Agrindustria) to verify it with continuous feedbacks and to realize a concrete replicable pilot project. It is demonstrated that the green energy production in systemic nets of small and distributed plants helps the success and the sustainability of territories.

## Research field: justifications and actors

The **goal of this research** is to **design a framework for Local Economic Development (LED) through Systemic Design (SD)**. The socio-economical growth is strictly connected with the access to a secure and affordable supply of energy, because with a permanent availability of energy in its various forms, especially electricity, people can learn, produce, share and increase their activities in wide meaning. But the emissions associated with energy generation and consumption is also central to number of key environmental issues. Therefore, the aim is to define sustainable models using a holistic theory that take into account not only the economical and environmental aspects, but also the social ones.

The **research field** is the energy sector, in particular the **production of green energy from renewable resources** (wood, biomass, waste), and not perpetual (sun, wind, water). This research will focus on the production even if it is strictly linked to the consumption of it. The goal is to satisfy the actual need with a larger share of bioenergy, because of ethical motivation explained below.

The economic evaluation of energy provides a **quantitative index** of its importance. Everyone knows that the price of oil influences global market, but only when we are faced with emergencies, such as the blackouts occurring throughout the world in the last years, we start to realize the **qualitative effects** of insufficient energy. Globalized society is touching the limit of its development and is becoming aware of its dependency on energy sources and its need to achieve sustainability for its consumption requirements in a complex scenario of social, economical, geopolitical influences.

The **reasons because this research is focused on energy sector** could be grouped into three levels (*figure 1*):

- **individual justifications**: the energy is a human right for the self-improvement; it increases the personal *capabilities* in the holistic sense of the indian economist A. Sen (1985). Citizens consume energy, but they give it back in form of social and collective intelligence, amplifying their effect on the territory.
- **regional justifications**: the well integrated energy with its area can straighten the relations among different actors: institution, private sector and communities. A *participated design* helps to create awareness and heightens the level of commitment on the parts that everyone co-designs. Involving the private sector could encourage direct dialogue with sub-national authorities and, at the same time, open new markets to identify new financial sources. They could also bring about economic gains for the region and the people in the community.
- **national justifications**: the economical aspects of energy are related to the *competitiveness* of a country because of the raw materials cost, that takes on a supranational role, creating worldwide political and economic dynamics. In that sense, the economic aspects are strictly related to political aspects. The countries are (inter)dependent one to the other and those relations can change by the decision of few people, but can have consequences on the population. The situation becomes worse when the resources are not-renewable or generate high environmental risks, because in that case they are strictly related with the social aspects, of safety and quality of life.

In that complex scenarios the **actors involved** are:

- **citizens**: energy, as *commodity*, is a customer's *right* and should be safe for the environment and for the people's health;



- **public administration:** energy, as *public good*, is a *need* and moves complex geopolitical strategies;

- **companies:** energy, as *asset*, is a *profit* and contributes the economical growth.

The European population growth<sup>1</sup> is comparatively slow in relation to the world's other continents, but the usage of resources and energy is increasing, because of its living standards.

Given current trends and policies, final energy demand is expected to increase over the period to 2030, requiring additional generation capacities<sup>2</sup>.

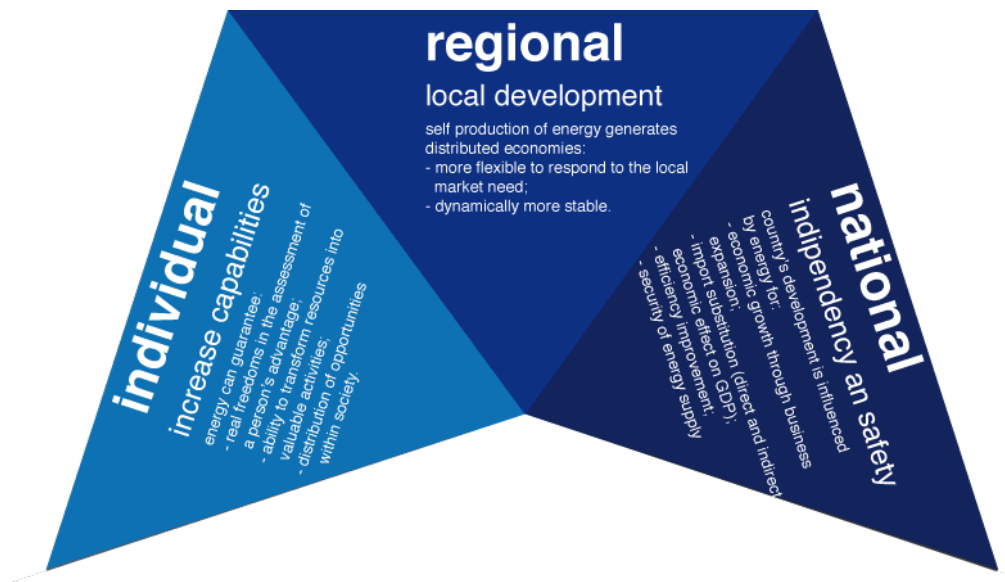


figure I: Research field justifications

**The greatest energy demand is actually faced into two ways:** by **increasing exploitation** of the planet's resources and by conducting a more intensive search for **energy efficiency**. These solutions, however, create rebound effects that **do not guarantee the long-term sustainable development** we are hoping for. The legitimate expectations of energy procurement are only valid in conditions of limit or sustainability, following the **ethical principles** of responsibility and precaution.

If we consider the not renewable energies (mainly oil and natural gas), it comes into play the **responsibility principle**, by which the ethic decision should follow the infra-generational (towards present generations) and inter-generational (towards future generations) equity. Those resources are limited to natural deposits that do not follow geographical or political balances. So nowadays we are facing many problems related to the power that few countries have on the other, just because they own the reserves. Furthermore, those deposits are not unlimited, so before or later (it depends on the resources, on the technology to extract them and on the previsions done by different

<sup>1</sup> On 1st January 2010, the population of the EU27 was estimated at 501.1 million, that grew with an annual rate of 2.7%, due to a natural increase of 0.5 million (+1.0%) and net migration of 0.9 million (+1.7%). Source: Eurostat, 27 July 2010.

<sup>2</sup> From PRIMES source, the final electricity demand in 2005 was 2,762 TWh and it will be around 3,000 TWh in 2020. Under the baseline scenario, the EU would need a net power capacity in the year 2020 which is, depending on the oil prices, about 160 or 200 GW higher than today. Under the New Energy Policy scenario, the net power capacity in the year 2020 would be higher than today by about 150 GW, with moderate oil prices, and 180 GW with higher prices. Source: State of play in EU energy policy, 30 November 2010.



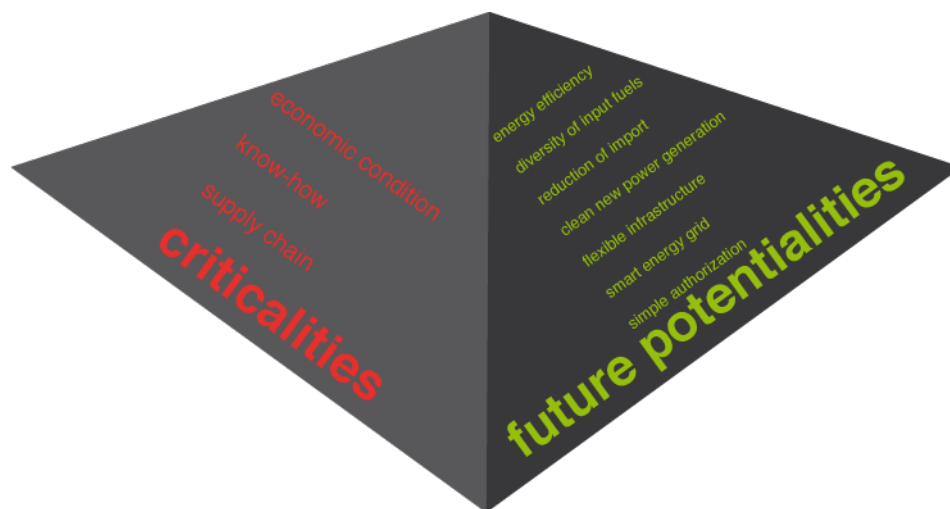
scientists)<sup>3</sup> they will run out. For sure, the fact that future generations will need the same, or more, amount of energy without the possibility to afford the natural resources is not fair.

If we consider the energy with high environmental risk, like the nuclear, it comes into play the **precaution principle**. It states that proper measures should be taken against the reasonable doubt that an action or behavior could cause a serious and potentially fatal damage to the community, even in absence of evidence to substantiate this. That is the typical case of nuclear power station and their safety not only for the environment, but for the workers and the people that live in the surroundings.

A radically new approach to this issue, which goes beyond specific technological solutions, is necessary to redesign the flows of material and energy resources and relationships within its local context and generate multiple and qualitative solutions (Bistagnino, 2009). In that sense renewable (wood, biomass, waste) or perpetual (sun, wind, water) resources can produce an “ethic” energy and their socio-environmental benefits can be exponentially increased by the use of natural waste in power generation. Our society continuously produces waste, more or less re-using, with constant renewability. It also becomes a matter of introducing and adding flexible energy technologies and designing integrated energy system solutions.

Nevertheless, the **principle of beneficence** states that the actions should move towards the benefit, and not only avoid the harm (Sgreccia 2007).

The European Union (EU)’s energy production has been declining in the last five years, where the largest share is the nuclear (30%), followed by solid fuels (22%), gas (20%), oil (14%) and renewable resources (14%), although the contribution of the latter is expected to increase significantly in the future. In any case, the current fuel mix varies widely in the EU Member States; to a certain degree it depends on the domestic resource/production pattern (*figure II*).



*figure II: Overall energy status in EU with its criticalities and future potentialities.*

The goals of **EU’s New Energy Policy** are to reduce of 20% in Green-House Gas (GHG) emissions compared to 1990, along with the production of 20% share from renewables in the final energy

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<sup>3</sup> The actual index of residual life of the verified reserves of oil (39 years) and natural gas (62 years) achieve respectively 86 and 126 years, if we take in consideration only the conventional technically recoverable resources; 129 and 211 years, if we consider also the unconventional technically recoverable resources. *Source: State of play in EU energy policy, 30 November 2010.*

demand by 2020, and to bring about a substantial improvement in energy efficiency<sup>4</sup>. **The focus of this research is in the second point: design a framework to encourage and represent the production of energy from renewable resources.**

With current trends and policies, the oil and gas share in primary energy consumption is expected to remain stable in 2020 at a level comparable to the current one. High oil prices would reduce the oil and gas share by 4% in 2020. With the New Energy Policy the figure would be between 55% and 59%, with high oil prices leading to a stronger decline in the oil and gas share. The share of renewables would increase under all scenarios and price circumstances<sup>5</sup>.

In the EU, there is a range of supportive policy measures relevant for renewable energy. These policy measures are spread across energy, agriculture and climate policy fields.

Additionally, the policy goals are related to many topics, including liquid biofuels for transport, electricity and heat from renewable energy, GHG emissions, and energy crops. The types of policy measures range from the Kyoto Protocol to the Common Agricultural Policy (CAP) and to the EU Directive on the Promotion of the Biofuels for Transport.

In 2005, the European Commission released the **Biomass Action Plan** (BAP) for Europe to accelerate the development of bioenergy, and to identify potentials and targets for biomass resources in terms of wood from forest, organic waste, wood industry residues, agricultural and food processing manure, and energy crops from agriculture. Furthermore, the European Environmental Agency states that realizing the targets for bioenergy as indicated in the BAP can be compatible (under proper management) with protecting and maintaining biodiversity, soil and water resources.

Achieving the many stipulated targets will require the development of effective policy measures that can stimulate innovation processes and engage key stakeholders.

In this complex situation, **Europe is facing three main barriers to the development of green energy generation** (McCormick, 2007):

- **Economic conditions:** renewable energy should compete with fossil fuels and nuclear power, which have received and continue to benefit from energy subsidies and externalized costs. Renewable energy often produces *positive impacts* that are not compensated by energy markets.

- **Know-how and institutional capacity:** it is necessary a combination of know-how and institutional capacity to shift from unrealized potential to success. Learning processes and altering perceptions of both public and politicians about renewable energy is often required to build up a *legitimacy* for that kind of production.

- **Supply chain coordination:** those kinds of complex systems involve many actors, so they require functioning and organized supply chains that overcome the “chicken and egg” problems<sup>6</sup>.

This research will take into account all these problems to advance a **new model of green energy productions to develop LED using SD methodology**.

## **Research methodology: combination of desk and field research**

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<sup>4</sup> Climate Action – Energy for a Changing World, 23 January 2008.

<sup>5</sup> European Commission Directorate General for Energy and Transport, Market Observatory for Energy, Europe’s Energy position. Present & Future, Luxembourg, Report 2008.

<sup>6</sup> Coordination and participation among actors in taking decisions help to avoid misunderstanding and to solve problems with effective actions.

The **research methodology** used to reach the goal is based on the **combination of theory and practice that resolves into a cross analysis**. The **theory of Systemic Design** and the **practice of case studies** are tackled with the same key questions: *what, why, when, where* and *how* (figure III).

**What is Systemic Design** is clarified by a historical excursus of its origins (generative science, cluster theory, industrial ecology, and industrial symbiosis); to understand the differences and the evolution in the time, and by its theoretical principles, to underline their innovation and enhancement.

On the basis that **living systems are open**, they continually draw upon external sources of energy and maintain a stable state of low entropy, as the physicist Erwin Schrödinger asserted in 1946; some of the next theories on industrial processes applied that concept also on artificial systems. Material and energy loops are open in order to decrease environmental impacts and resource depletion.

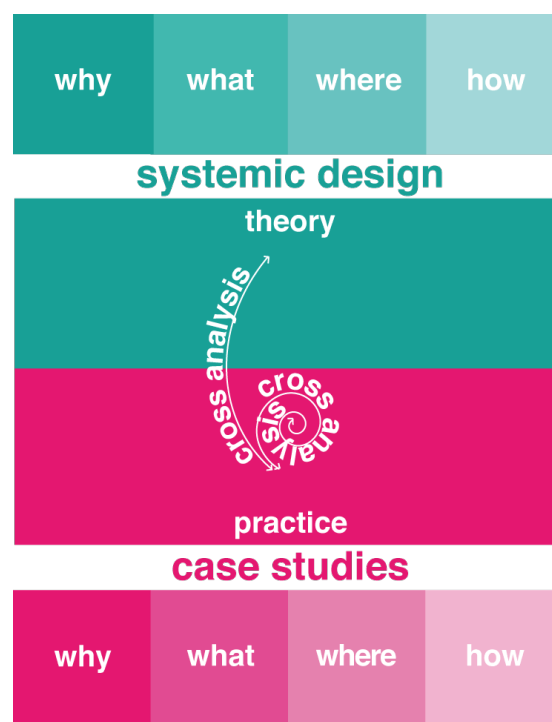


figure III: Structure of the research methodology with combination of theory and practice.

The methodology of **SD looks at making a better use of material and energy flows** in order to model industrial production and energy systems after nature. Many industrial ecosystems have come about *ad hoc* for better business, while others have been facilitated through external actors. However, as these theories and ventures may be innovative for the industries, they are still no more than solving problems that arose from environmental pressure and economical revisions (Bistagnino, 2009).

The theory of SD offers a scientific method that derives from the generative science and from other eco-management theories. It can be summed up by its **five basic principles**:

1) **Person at the centre of the project**: the product has become fulcrum of a paradigm of values and actions, as the economical wellness, the quantity of resources, and the wish of belonging to a social status: that shapes negatively consumption choices. The systemic approach, instead, questions the present industrial setting and proposes a new paradigm where at the centre of each productive process there are social, cultural, ethical and biological values.

2) **Output>Input**: as in nature what is not used by a system becomes a raw material for the development and survival of someone/something else, in industrial processes the waste (output) of a system becomes an opportunity (input) for another one, creating new economic opportunities and new jobs.

3) **Relationship**: it is important to consider, more broadly, all the networks of components, including materials (resources) and energy, which are used, captured and stored through different stages of the product life cycle. Understanding the pattern of materials and energy flow and investigating where it can be improved can allow to find entry-points for designing more sustainable system.

4) **Towards autopoiesis**: in nature self-maintaining systems sustain themselves by reproducing automatically, thus allowing them to define their own paths of action. In this way, the system is naturally led to balance and preserves its independence. If also in industrial system we would start in terms of autopoiesis, it could be possible to allocate efficiently and distribute equally the material and energy flow.

5) **Act locally**: as an ecosystem is deeply influenced and shaped by its habitat, the same happens for any other type of system. Based on the opportunities provided by the local context, new opportunities can be created by reducing the problems of adaptability due to general solution and increasing people's participation.

**Why the SD methodology** was used to design LED centred on green energy production is embedded in its historical background (and its innovation), and in its consistency. The **evolution of the concept** that industrial processes can work like nature shows how the SD theory adds some crucial elements to previous theories making them more effective. Researches who utilize a systemic approach have a **significant interest** in leverage points within complex systems where a small shift in one parameter can have large impacts (Meadows, 1999).

**When** did the Systemic thinking begin to be defined? It was in the early XX century in particular in biology, physics, psychology and ecology but only in 50s it started to influence also the engineering and economics, generating the systemic management. Practical experiences in the field of industrial processes came in the 70s. This research has a general overview about the origin of SD, but it focuses for the practical experiences in the last decades.

The SD finds its actual theorization and practical experimentation is in Politecnico di Torino (Bistagnino, Lanzavecchia, 1998), **where** in the late 90s starts a cooperation with the Foundation Zero Emissions Research and Initiatives (ZERI) in Switzerland (Pauli, 1994). The results was a method with clear and specific principles that can be applied into concrete fields (from agroindustry to events) as shown in Bistagnino's last book "*Design Sistemico. progettare la sostenibilità produttiva e ambientale*" (Slow Food Editore, 2009). In Pauli's last book "*The Blue Economy: 100 Innovations inspired by nature that can generate over decade 100 million jobs*" (Paradigm Publications, 2010), there are a series of new businesses inspired by nature. The new business model proposed by SD booms in the philosophical concepts of Fritjof Capra, the founder of the Center for Ecoliteracy in Berkeley (USA). A part the design field, the main features of systemic thinking have been taken shape thanks to different disciplines like quantum physics, ecology, cybernetics, and economy.

**How the Systemic Design** is used in this research: in the **theory for planning** and in the **practice for reflecting**. To serve the dual purpose of being part of doing research and intervention at the same time, this research faces the challenge of being able to get sufficiently involved in action and stand back, when necessary, from action and reflect on it, as it happens, to contribute to the theory and the body of knowledge. This research is built upon showing the European energy situation, synthesising the information from relevant literature about SD, and analysing eight case studies.

The need for a better understanding regarding SD concepts contributes to intensify local sustainability and to test it. Such understanding is particularly important to give a new direction to SD work that can potentially catalyze deeper changes. Such understanding was sought through studying selected production systems that resulted useful lessons. These systems were selected so that systemic relations are operational, or planned, in particular the *output>input principle*.

**Which case studies** are analyzed in this research can be grouped into two main categories: the **macro-systems** and the **micro-systems**. In the first case, they are large-scale plants that provide energy to entire cities (i.e. *Växjö*) or districts (i.e. *Vignolo*); in the second case, they are small-scale plants that supply just a factory (i.e. *Bioagro*) or a single house (i.e. *Villa Ödman*).

The **motivations** in choosing these **eight case studies** stay in the **approach**, the **size**, and the **experiences**. The selection of case studies is based on:

- the production of bioenergy;
- the complexity they have with more or less large networks of companies;
- the compliance with the SD principles, above all the tendency to zero emissions.

The different size of plants allows to understand the regional effects with macro-systems and the local effects with micro-systems. In that way, the limits in using local resources to produce green energy become evident.

The case studies are located specifically in Sweden and Italy. The first country has been chosen for its long experience in bioenergy and because its approach to the field is more holistic than other experienced countries, i.e. Germany (in any case only few Member States in the EU could be described as having significant share of green energy). The second country has been chosen because of its strong theory in SD and because of supporter feeling to help that country to reach the European targets in the production of energy from renewable resources.

**When the case studies** has been analyzed is mainly during the second year of this research after having acquired a strong awareness in the method and the ability to practice the tools. Once the interaction with the real life cases has started the research was dominantly focused on what is believed to be the bottleneck by the time. In light of the improved understanding, the results become evident and the framework designed, together with a experimentation, that was improved into practice in the Italian micro-system (*Agroindustria*).

**Where the case studies** are settled was clarified above with the experience motivations (in Sweden and in Italy) to have a complete scenario at theoretical and experienced levels. The project would join the experiences in the bioenergy production from Nordic Countries with the methodology in SD from Italy; to promote new and renewable energy sources, from biomass residues, decentralization production of electricity and heat, and its diversification.

**How the cases** are analysed cover at 360 degree of understanding: initially they were selected and studied in literature (*desk research*), then visited in site (*field research*) and finally reflected with continuous feedback and interaction. The selection was important because each one should respect the fifth SD principles and not often there were enough public information and references. So those cases studies heavily rely on site visits to observe companies and projects in action, meet and interview informants in their “home” environments and “experience” in some how the complex systems. Additionally, key informants were often at ease and eager to show and explain in detail the development of “their” green energy systems (Stake, 1995). The pictures taken during the site visits capture observations and help “to be in the place” with hindsight. The site visits played a crucial role in the research process and the case studies. At the end those cases were synthesized in homogeneous and structured form put in the annexes of this thesis. The common format shows the following elements of analysis: localization, historical background, objectives and strategies,

activities, focus on environment, focus on job, main actors and promoters, funds and financing, future projects, references, and websites.

This common format allows a **cross analysis of the cases and of the theoretical with practical parts**. That is the crucial part of this research where the main result emerges: to design the framework, which is continually verified in the Agrindustria best-practice. The format is used for identifying, collecting and analysing data, so they can be comparable in vertical (comparability of the same parameter among different case studies) and in horizontal (comparability of the parameters in the same case study) way. That analysis wants to turn the theoretical knowledge into pathways of change that are suitable to the specific needs and capacities of regions or localities. This demand engaging the relevant parties in all stages of the change process and enhancing their capacity to effectively address the future sustainability challenges. Although satisfying these latter ambitions can and should be guided by the knowledge provided by the methodology, acquiring a thorough understanding of the dynamic and complex systems and their sub-components for which changes are desired become key. Looking ahead the development of a multidisciplinary vision becomes crucial, in that way various skills are brought together, towards the emergence of a new culture of sustainable economic and technological innovation and process inspired by the dynamic operation of nature, that is the ultimate system.

Utilizing a **combination of desk and field research** lets on a more in-depth understanding of reality from different viewpoints, which is crucial when exploring topics or issues involving a range of actors, like the energy sector. This research is heavily focused on qualitative methods, including literature reviews, case studies, site visits, stakeholder interviews, industry interactions and international agencies connections. The foundation of this research is therefore the use of **diverse kinds of data sources** and a **mix of qualitative methods**. The *desk research* detects the information already written by others, in a important identification of the sources with their reliability. The *field research* directly observes the reality with empirical and personal experience. That means the *desk research* is less expensive and also less original; but it helps to define the headway processes of the research. The combination of *desk* and *field research* guarantees a reach and deep understanding of the facts to define an **original framework** (Celaschi & Deserti, 2007).

Rather than setting out with a proven “one-fits-all” solution in hand to catalyze the development of SD networks, this research primarily focuses on continuously “fine-tuning” and approach so as to make it best suited to dynamic specific contexts.

## Conclusions: implications of results for future policy

The **main result** of this research is a **framework supporting the evolution of a new economy** with different sets of industrial relations, where long-term sustainability and success of interdependent activities are priorities over maximising economic growth or competitive advantage of individual entities. The projects based on renewable energy, teach how the creation of sustainable infrastructures and agile energy systems could develop a region. So the conclusion is that **green energy produced in small plants and distributed in the territory** favours the success and the sustainability. Reading in the right way the environment is possible to design the right technology that produce green energy and that is connected with other renewable resources. Such **agile system** can be a new paradigm for both energy efficiency and reliability for any region or country (*figure IV*).

From the opening of the energy market, companies had new possibilities to design energy supply scheme and policy. Most companies have not developed yet technical and economical know-how to deal with distributed energy generation concept and are still concentrating mainly on their core-business and on short-coming economical performances. The **theoretical model was tested and**



**improved with the practical experimentation in Agrindustria**, so the **designed framework is already verified** and the **pilot project is replicable**.

The development of **Distributed Energy Resources concept** is linked to the **territorial specific features**, both from natural resources and human activities point of view. This is currently not well established and, paradoxically, it can be noted that the liberalization of electricity market can favour the opposite situation of customers buying energy from a very distant and different territory, wasting the local potential of energy generation.

**Local communities** will benefit from implementation of the project directly through a rational use of energy resources and the enhancement of those type of renewable low environmental impact; indirectly because the implementation of that framework will vehicle a spreading of new culture and also the emergence of local initiatives relating to environmental issue. Finally, the **government** and the **municipalities** also will receive the results of the proposal because from the observation of socio-economic system generated from the implementation of this project, will allow local administrators to acquire the tools to make a set of guidelines for creating a plan for local sustainability in the medium term, and the creation of new normative instruments to respond to sustainability requirements. With the cooperation of **universities**, **companies** and **public bodies**, the exchange of proficiencies between expert local organizations and learning local organizations are facilitated. The goal is to institutionalize sustainable energy policies and implement sustainable energy action plans.



*figure IV: Research goal.*

In conclusion, the adoption of more **systemic productions** and **person-centered approaches**, including more innovative capture and generation of energy holds great potential to create LED. When the linkages between materials, energy, people and their knowledge are mapped out clearly, efficient pathways towards sustainable ways to use and re-use untapped resources will become apparent. Using these networks, energy systems can be collectively innovated, so they are beneficial and pleasurable for the people the environment. In the field of renewable energy the creation of sustainable infrastructures and agile energy systems could develop a region. **Green energy produced in small plants and distributed in territories helps the success and the sustainability** (*figure V*).

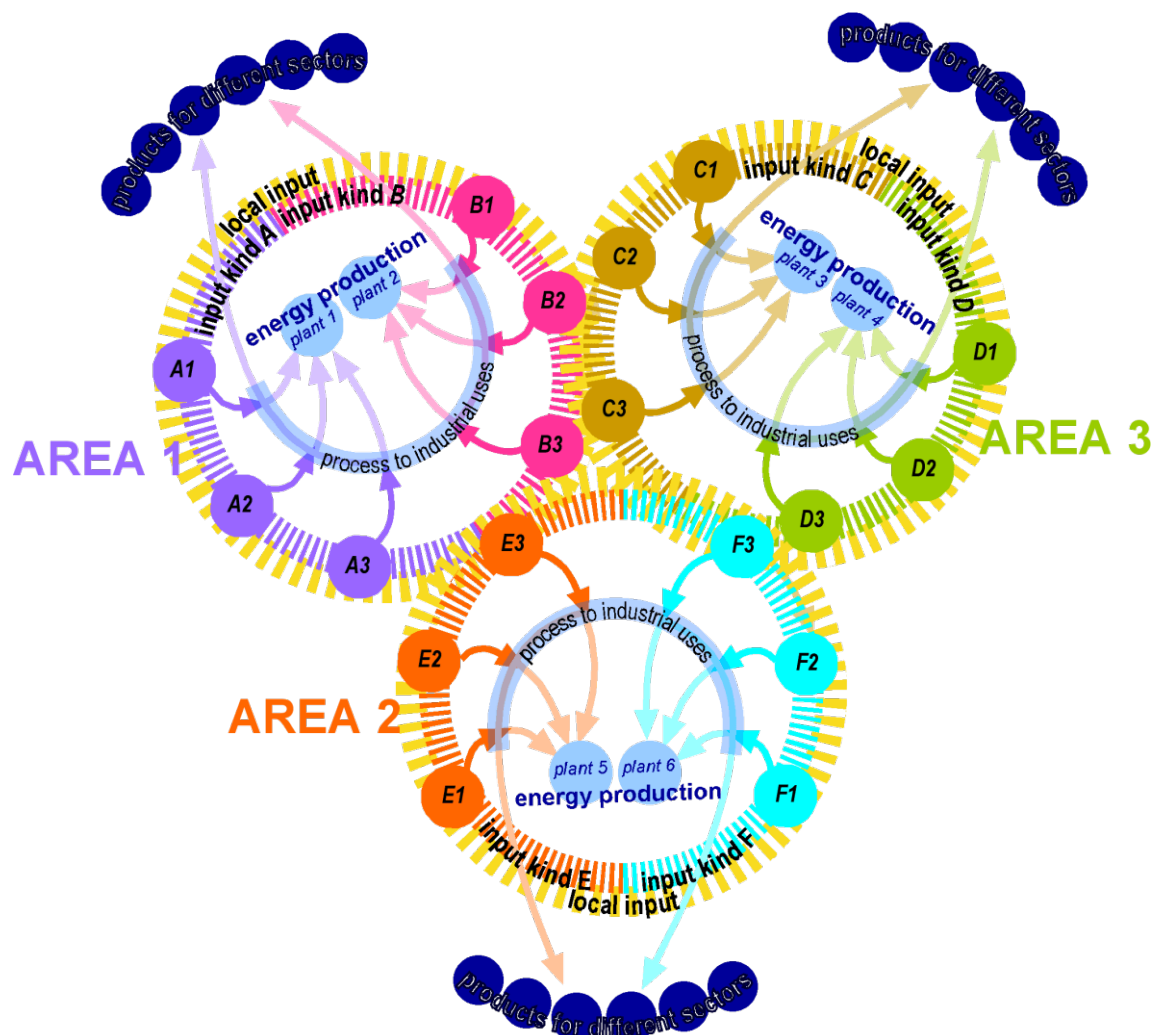


figure V: Green energy produced in small and flexible plants distributed in the territory.



## References

- Barbero S., *Systemic Design In The Energy Sector: Theory And Case Studies*. In: Management of Technology Step to Sustainability Production. Rovinj, 2-4 June 2010.
- Barbero S., *Systemic Design to Develop Local Distributed Economies*. In: Junior Scientist Conference 2010 – Proceedings Technische Universitat Wien, p. 433-435, Vienna, 7-9 April 2010
- Bistagnino, L. (2011). *Systemic Design. Designing the productive and environmental sustainability*. Bra (CN), Italy: Slow Food Editore.
- Bistagnino L., Lanzavecchia C., *Dal Semplice al Complesso*, In: Meccanica & Automazione, J Publishing & Media, Milano, 1998
- Brown L. R., *Plan B 4.0: Mobilizing to Save Civilization*, W.W. Norton & Company, New York, 2009
- Campagnaro C., *Cinque miliardi di sfere*, Casa Editrice Ambrosiana, Zanichelli, Cesano Boscone (MI) 2008
- Capra, F. (2002). *The hidden connections: A science for sustainable living*. New York, NY: Doubleday.
- Commission Staff Working Document, *Europe's current and future Energy position: Demands – resources – investments*, First Annual Report of the European Commission's Market Observatory for Energy, Luxembourg (Belgium), 13 November 2008
- Commission Staff working document, *State of play in the EU energy policy*, accompanying document to the Communication from the Commission to the Council, the European Parliament, the European Economic and Social Committee and the Committee of the Regions, *Energy 2020 - A strategy for competitive, sustainable and secure energy*, Brussels, 2010.
- McCormick K., *Advancing Bioenergy in Europe. Exploring bioenergy systems and socio-political issues*, doctoral dissertation, The International Institute for Industrial Environmental Economics, Lund, 2007.
- Forrester J. W., *Industrial Dynamics – after the first Decade*, In: Management Science, Vol. 14, n. 7. Pp. 398-415, Hanover (MD), 1968
- Germak, C. (2008). *Man at the centre of the project. Design for a New Humanism*. Turin, Italy: Allemandi & C.
- Quintero B. C., *Manual del professor para la enseñanza de la metodología ZERI*, Editore, Luogo, 1995
- Laybourn P., Morrissey M., National Industrial Symbiosis Program: The pathway to low carbon economy, International Synergies Ltd, Birmingham (UK), 2009
- Lanzavecchia C., *Il fare ecologico*, Time&Mind, Torino, 2004 (Paravia, Torino 2000)
- Lovins, A. B., & Hawken, P., & Lovins, L. H. (1999). *Natural capitalism: Creating the next industrial revolution*. New York, NY: Little Brown&Company.
- Mandelbrot, B. B. (1982). *The Fractal Geometry of the Nature*. New York, NY: W.H. Freeman and Company.
- Maturana, H. R., & Varela, F.J. (1972). *De Maquinas y Seres Vivos. Una teoria sobre la organizacion biologica*. Santiago de Chile, Chile: Editorial Universitaria.
- McCormick, K. (2007). *Advancing Bioenergy in Europe. Exploring bioenergy systems and socio-political issues* (Published doctoral dissertation). The International Institute for Industrial Environmental Economics, Lund, Sweden.
- Meadows, D. (1999). *Leverage points: places to intervene in a System*. Hartland, WI: Sustainability Institute.
- Mirata, M. (2005). *Industrial Symbiosis. A tool for more sustainable regions?* (Published doctoral dissertation). The International Institute for Industrial Environmental Economics, Lund, Sweden.
- Mirata M., *Experiences from Early Stages of National Industrial Symbiosis Programme in the UK: Determinants and coordination Challenges*, In: Journal of Cleaner Production, Vol. 12, n. 8-10, pp 967-983, Elsevier, ,2004
- Nicolis, G., & Prigogine, I. (1989). *Exploring complexity. An Introduction*. New York, NY: W.H. Freeman & Company.
- Pauli, G., *The Blue Economy: 100 Innovations inspired by nature that can generate over a decade 100 million jobs*, Paradigm Publications, Taos (NM) 2010
- Pauli, G., *Breakthroughs: What business can offer society*. Epsilon Press, Surrey (UK), 1996.
- Peccei, A. (1974). *Quale futuro? L'ora della verità si avvicina*. Milan, Italy: Biblioteca dell'EST.
- Regge T. e Pallante M., *Scienza e ambiente. Un dialogo*, Bollati Bolingheri, Torino 1996

- Rifkin J., *The Empathic Civilization: the race to global consciousness in a World in crisis*, Tarcher, New York, 2009
- Rifkin J., *The Hydrogen Economy*, Tarcher, New York, 2002
- Sgreccia, E. (2007). *Manuale di Bioetica. Fondamenti ed etica biomedical, 1*. Milan, Italy: Vita e Pensiero.
- Shrödinger, E. (1946). *What is Life? The physical aspects of living cells*. Cambridge, UK: Cambridge University Press - The Macmillan Company.
- Stake R. E., *The Art of case study research*, Sage Publication, Thousand Oaks, 1995.
- Thackara J., *In the bubble. Designing in a Complex World*, MIT Press, Cambridge (Mass), 2005.
- Von Bertalanffy, L. (1969). *General System Theory: Foundations, development, applications*. New York, NY: George Braziller, Inc.

**Process analysis of the dynamics of eco-industrial park's development: a case study of TEDA in China**

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**Keywords: eco-industrial park, industrial symbiosis, process analysis, circular economy**

**1. Introduction**

In the last two decades, eco-industrial park (EIP) has become a policy-driven attempt to apply the principles of industrial ecology and sustainable development (Gibbs, 2009) to reduce the environmental impact of economic activities. The core of EIP is industrial symbiosis (IS) i.e. engaging traditionally separated industries in a collective approach for competitive advantage involving physical exchange of materials and by-products, shared management of common utilities and infrastructure to provide process water, energy or common treatment of effluents and wastes (Chertow, 2000). The eco-transformation of an industrial park doesn't come about overnight. By contrast, it is a progressive process embedded in a socio-technical context and requires the fundamental changes through the co-evolution of technological and institutional systems (Dijkema and Basson, 2009). However, the relevant methodologies and approaches about EIP can't well understand how the changes unfold in the micro level during the development of an EIP system.

Thus this research **aims to** develop a replicable approach which can allow analysts to structure the key activities influencing changes in EIP systems, as well as track the dynamic process of the system development in different institutional contexts. To reach this goal, **three research questions** will be answered:

- What factors (can) influence the evolution of EIPs?
- How can we trace and illustrate the changes in EIPs unfolding over time?
- What mechanisms can be extracted to explain these changes?

This paper will unfold as follows. Section 2 introduces the method of process analysis and how it can be adapted to study an EIP's development. In section 3, the approach is then applied to a well-known current case, that of the Tianjin Economic-technological Development Area (TEDA) in China. TEDA initiated the eco-transformation since 2000 and it has become the National Demonstration EIP in China. Evidences show that the IS networks are emerging in TEDA stimulated by several institutional and management instruments. After a general introduction of this case, the generic framework developed in section 2 will be utilized here to make sense of this case in terms of its development process. Not only will it help us to understand the case as such, it will also clarify the way in which this process analysis approach is used in practice. In the end, this research will draw some generic conclusions on the determinants for successful eco-transformation of industrial parks. Authors

hope that this approach provides a novel view to illustrate and comprehend the dynamics of EIP development and to learn lessons from historical and current cases for future ones.

## **2. Method**

Generally, chronological narrative analysis is used to describe the process of EIP evolution. Many scholars devote their work on case studies to explain in detail what happened during the development of various IS projects. However, a knowledge gap remains after reading them as to how to trace the determining factors unfolding over time and their integrative effect at the EIP systems level. Furthermore, narrative analyses cannot be but context-specific, thus lacking a common and generic (cross-case) framework to from which patterns for comparison and generalization can be extracted and determinants for success and failure can be discerned.

To better understand what drives the changes of an EIP and how the changes unfold during the development, this research adapts process analysis which aims to capture and explain the different types of forces and mechanisms that can influence the change and development. Process is defined as a sequence of events that describe how things change over time. The point of process analysis is to obtain the meaningful insights into the changes unfolding over the duration of a subject's existence (Poole et al., 2000). The advantage of this approach is the rich qualitative information about the processes, meanwhile its quantitative characteristic also overcomes the drawback of the individual case study lacking of generalizability. Process analysis has inspired us to find a set of key activities from the literature on EIP/IS and use them as variables to track the events from the empirical data for event sequence analysis. This approach can assist us to observe the changes during the eco-transformation of industrial parks from a system's perspective.

In order to investigate the important factors promoting or hindering IS/EIP projects, 46 journal papers are reviewed to seek these elements and classify them into different groups of key activities for tracing the related events in the empirical research, i.e. institutional activity, technical facilitation, economic and financial enablers, informational activity and company activity. The role of each key activity is further explained in the paper. Moreover, in order to trace these activities from the empirical materials, we use a list of indicators to map the events influencing the changes of an EIP.

## **3. Case study on process analysis about the eco-transformation of TEDA**

To test the framework application, we apply the framework and the method to a Chinese EIP-TEDA who started the eco-transformation since 2000. First, we describe the milestone events that had a profound impact in terms of institutional activity, technical facilitation, economic and financial enablers, informational activity and company activity. Second, a system analysis is presented based on the database with the historical events from 2000 to 2011 according to the indicators of the key activities. During data collection, we kept as much as possible the holistic effects at the system level in view, influenced by the forces and interaction from the 5 key activities. We focus on the data sources at park level about TEDA's eco-transformation, such as news, reports and yearbooks, especially from the websites of TEDA, the Eco-center, and TEDA's Environment Protection Bureau (EPB). The events are counted over time with the same weight and plotted in the figures. The trends of the 5 key activities through time are analyzed to explain the dynamics of TEDA's eco-transformation. Moreover, we interviewed TEDA's Administrative Committee, the EPB, the Public Utilities Bureau and TEDA's Eco-center to come to a better understanding of the drivers and barriers during TEDA's eco-transformation, and to triangulate our own observations and analysis.

The system analysis we present is based on the event sequence analysis of the 5 key activities. Basically, the years 2000-2005 were the initiative era of TEDA's eco-transformation with the themes of cleaner production, ISO14000 and construction of environmental infrastructures. They were characterized by the fact that the IS-related company activities were not very significant. During this era, the emphasis of the planning and guidance was on intra-firm cleaner production, building water treatment and co-generation plants, and connecting the industrial chains through inviting the complementary companies. There were few events related to economic and financial incentives specifically for encouraging company activities in this era. And the informational activities were at a stable and low level, mainly concentrated on feasibility studies for material flows and solid waste management. Unlike the culture of cooperation in Kalundborg, the companies in TEDA lacked of inter-firm communication most of the time. Besides, the fragmented industrial composition cannot provide adequate possibilities for emerging synergies within and among sectors. Furthermore, there was no main coordination body in this period to solve the situation of incomplete information, nor to disseminate new IS-related ideas to the wider business community within TEDA. As a result, by-product exchange and information disclosure among companies was not very substantial.

The tide seems to have changed since 2006 when the Implementation Plan for TEDA's Circular Economy Pilot was carried out. In this era, IS-related company activities increased markedly and physical synergies gradually emerged. Prevalent institutional incentives triggered companies' spontaneous behavior to share information and join the IS network. The trend of growing institutional activity implies a positive governmental involvement in building up the institutional environment for IS in TEDA. Meanwhile the monitoring and evaluation on the environmental impacts were also strengthened. The companies that failed the evaluations could be deprived of preferential policies. As the new environmental infrastructures were launched, more and more companies began to use recycled water and steam subsidized by the TEDA Administrative Committee. The special funds in 2007 for environmental protection projects and energy saving gave an impulse to company participation. Since then, the economic incentives have been strengthened consistently. The economic awards were also given to the companies that kept publishing their environmental information. Meanwhile, the coordination body, TEDA's Eco-center, functioned as a broker to provide the information and knowledge for building IS relationships, and to identify the potential opportunities for by-product exchanges. That explains the remarkable growth of informational activities since 2010 when the Eco-center was set up. IS awareness and inter-firm communication was enhanced through several conferences and trainings organized by the Eco-center. Meanwhile, as economic incentives were offered, companies were encouraged to consider alternative solutions for solid waste reclamation and wastewater treatment. Networking activities created more opportunities for by-product exchange as well. Consequently, the rapid surge of company activities occurred in 2010 on physical synergies, information exchange and disclosure.

#### **4. Conclusion**

In this article, we have generated a framework which integrates the key activities driving the evolution of an EIP as well as indicators to trace the events relevant to these key activities. The framework was subsequently applied to the TEDA case based on a process analysis demonstrating how changes unfolded during TEDA's eco-transformation. We believe this

method to be largely applicable to other cases, although applying it to other, especially non-Chinese cases may lead to certain changes in focus or emphasis.

Through applying the method and the framework, we interpret the individual events over time to system analysis. It is learnt that understanding the eco-transformation of industrial parks requires dynamic system thinking. It is a progressive process co-shaped by various actors and forces in terms of institutional activity, technical facilitation, economic and financial enablers, informational activity and company activity. The actors in an organizational network conduct these key activities, while adapting to external changes and generating new strategies and modes of behavior. The fulfillment of each key activity is a means rather than a goal. The point is to capture the mechanisms determining the changes and then to steer the system change further in a desired direction.

The trajectory of TEDA implies a transition from “a planned EIP” to “a planned + facilitated EIP”. In TEDA, government planning comes first and is soon accompanied by other supporting policies. In the initiative era, high quality and low-price networking utilities were provided for water and energy utilization. Several goals were set to guild the direction of EIP, such as closed-loop chain and industrial symbiosis. Moreover, the local authority sets a coordinator for IS-related events. The coordinator strengthens the common understanding about IS business, spontaneous collaborative behavior among firms.

Policy-driven models like TEDA reveal the primary focus on and impact of institutional activity. Institutional arrangement can enable and shape the eco-transformation of industrial parks through strategic planning, incentive policies for recycling wastewater and solid waste, eco-labeling and environmental assessment, as well as monitoring and evaluation actions. Apart from formal rules, shared norms as to IS are also crucial, requiring informational activity allowing companies to internalize the values of cleaner production and IS and adapting their behavioral patterns accordingly. Thus informational activity is vital to shift companies’ awareness and existing business routines through training and networking, in order to mobilize more initiative synergy opportunities.

This paper analyzes the case in China who is making big efforts on circular economy but still has unsystematic institutional arrangement. These pre-conditions form the particular mechanisms for EIP’s development. In the further research, based on the same research approach, we hope to analyze other cases without government leading to capture and compare the different mechanisms.

### **Key References:**

- Chertow, M.R., 2000. Industrial symbiosis: literature and taxonomy. *Annual Review of Energy and the Environment* 25, 313-337.
- Dijkema, G.P.J., Basson, L., 2009. Complexity and Industrial Ecology. *Journal of Industrial Ecology* 13, 157-164.
- Gibbs, D., 2009. Eco-industrial parks and industrial ecology strategic niche or mainstream development, in: Boons, F., Howard-Grenville, J.A. (Eds.), *The social embeddedness of industrial ecology*. Edward Elgar.
- Poole, M.S., Ven, A.H.V.d., Dooley, K., Holmes, M.E., 2000. *Organizational change and innovation processes: theory and methods for research*. Oxford University Press.

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**Track:** 5c Regional sustainability: economic development and industrial symbiosis

**Title of the paper:** **Eco-Industrial Parks as an instrument for regional sustainable development – a system theoretical approach**

**Form of presentation:** oral

**Abstract**

*Just like industrial agglomerations in general, industrial parks exhibit a substantial ecological burden for their surrounding environment. The concept of Eco-Industrial Parks (EIP) pursues the objective of minimizing these environmental impacts. Public authorities are highly interested in the development of EIPs and are widely willing to support corresponding developments. However, a comprehensive implementation of the idea of EIPs has not been accomplished so far. It is the idea of this research project to analyse the relation between the politic and the EIPs by means of Niklas Luhmann's theory of social systems. By applying this approach it is possible to understand structures, impacts, and evolutionary mechanisms within an EIP as well as its relations to the environment and the political system. From a viewpoint of practical application the survey may support regional and municipal policies by providing recommendations for the promotion of EIPs (and therefore for an efficient allocation of funds). According to Luhmann, social systems are operatively closed and basically not controllable from outside. However, in exceptional cases a system might be irritated by its environment. The questions which could be answered by the system theory are: Which kind of communication will be perceived by the EIP system? What approaches of an irritation of the EIP-system are available to politics? What are the options for politics to translate their calls for a more socially and environmentally compatible park design into the language of the EIP system?*

## 1. Eco-industrial Parks and the necessity of political regulation

The concept of Eco-Industrial Parks (EIP) aims at both, improving the environmental performance of industrial agglomerations and gaining economic benefits. More precisely, with the aid of EIPs the input of resources and energy is intended to be minimised and the idea of recycling management should be implemented. Therefore the conventional industrial park is extended by environmentally compatible infrastructure and technologies. The foundations of a practical success of EIPs are a regionally minimal distance and a actors' willingness to cooperate. From their viewpoint an EIP offers potentially economic benefit such as advantages of localisation and urbanisation. (Sterr/Ott 2004, pp 955-956)

To what extent the EIP concept is advantageous for the region, depends not least on the stakeholder's depth of cooperation. In principle each industrial enterprise's settlement generates an **investment surplus**, i.e. a sustainment, extension resp. improvement of production potential by input of capital goods. The scope of this effect though is regionally limited. Cooperative relations are no precondition for gaining the investment surplus. Likewise no cooperation is required for a **neighbour ship surplus**, through a so-called passive integration of location. With it the attraction of location is affected based on field of externalities. Both, the investment surplus and neighbourhood surplus, are no exclusive feature of EIPs, but are also features of conventional industrial parks and other industrial agglomerations. However, an intentional local and systematic integration are distinctive features of EIPs, since they are based on cooperation of actors among themselves and with regional stakeholders. The local integration derives from division of labour and specialisation and it covers all processes of interaction and exchange. By patterns of networking and action secondary local features are generated, which then again give other accounting entities utility possibilities of the location and the further region (so-called **regional effects**). But only through system integration actual organisational systems emerge by networks and cooperation. Positive effect of those systems is the **compound surplus**. Preconditions for such a competitive edge are adequate structures of communication. (Staudacher 2005, pp 95–97).

In practice frequently only a low impact level is attained. Actual compound surpluses are gained only occasionally. Politics already gives support to EIP by subsidies, consulting services or the like, because they are considered as an instrument for sustainable regional development. Such interventions are legitimated with arguments of environmental and economic policy. But even if an intervention is reasonable from the society's viewpoint, the question remains whether and how a political controlling can succeed in the effort to gain compound surpluses.

This is the issue which will be investigated in the present paper. It is the idea of the study to analyse the capability of politics of controlling the development of EIPs, with the aid of the system theory of Niklas Luhmann. By the application of this approach it is possible, to better understand the relation of politics and economy (which also EIPs belong to) and therefore to highlight the scope of action of political controlling. It is the objective of the project to examine the following aspects: The question of control mechanisms; and subsequently an evaluation of possible intervention by regional policy. From a viewpoint of practical application the survey may support regional and municipal policies by providing recommendations for the promotion of EIPs (and therefore for an efficient allocation of funds).



The study is designed as a theoretical inquiry. Thus, in the first instance it is not intended to make recommendations for a certain concrete industrial park. Rather general ideas and conclusions concerning EIPs, including their significance for their surrounding region as well as results with regard to their controllability by public authorities will be discussed.

## **2. System theory and its application**

The distinctiveness of Niklas Luhmann's system theory in compared to other social theories arises from its non-constrained socialisation. The considered object is, unlike classical sociology, not the individual and its actions. Following Luhmann the system of society as well as its operational mode and dynamic of development can only be understood and explained by turning away from activeness of human beings and their physiological and psychological factors. (Görlitz/Adam 2003, p 284) In terms of system theory society consists of operations, more precisely: of communication. This perception is contrary to almost the entire sociological and philosophical tradition. (Kneer/Nassehi 2000, pp 65-68).

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## **3. Deficiencies of political controlling and regulation from a system theory's viewpoint**

A number of assumption of system theory deny any ability to control, consequently also any potential to intentional manipulation of an development of EIPs. How Luhmann gets to this conclusion is to be regarded more precisely in the following.

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environment is defined as a unit. Thus, each system has a different environment. And consequently: each system belongs to the environment of the other system. (Luhmann 1990, pp 23-24) In system theory's perspective the society has differentiated by specialization in subsystems (politics, economy, science etc.) on the common basis of communication, however by accordant special contents of communication. (Kneer/Nassehi 2000, pp 112-112) The systems do not relate hierarchical among each other. Additionally, there is no exclusive responsibility of the functional systems regarding certain duties. Thus, politics are not able to as well as not legitimated to represent the rationality of the entire society. Politics are not able to know what serves the social welfare's interest (lack of **knowledge about a requirement of change**). On the other hand it is based on its certain function and performance a special position among the social subsystems. Politics arises where binding decisions are needed in one of the other systems. In such a manner politics can intervene in economic contexts and has got a 'definitional power' for public interest beyond the system itself. (Ulrich 1994, pp 150-152)

In case of the EIP concept there are insufficient **definitions of objectives** due to insufficient definition of the EIP concept itself. So, it is not clear what from the viewpoint of politics is meant by sustainable development of industrial parks. In order to describe the EIP-concept the metaphor of the natural eco-system is widely used. There is nothing to have against it, since tropes make the issue visible. However, it gets problematic if a metaphor itself is used as an argument, because they are neither a concept nor normatively neutral. Just to mention shortly: The metaphor of the ecosystem used on the EIP concept oversimplified simply the natural system. At the same time the performance of economic system is underestimated. The evolution of nature is determined by genetic programs, while in economics there are intelligent agents. With such an unclear concept of EIP it is difficult to formulate concrete objectives and opportunities of operationalization. (McManus/Gibbs 2008, pp 530–535)

Political intervention with a target of sustainable design of industrial parks can succeed only, if operations, structures and essential processes of the EIP system are known so that the system behavior can be reconstructed and modeled. However the **knowledge about the object of controlling** EIP is limited, since the observation of the EIP by politics occurs exclusively by its own construction of reality. Also politics is not capable to take over information from its environment, but has to reconstruct the structures of the other system by theories and suppositions. (Ulrich 1994, p 90)

The pessimism on controlling in system theory is not only based on the limited perception towards the EIP-system. Moreover in the political system there is a deficiency of **knowledge considering its own mode of operation** and thus also regarding design of promising impulses of controlling. In the meantime the political subsystem has built up complex structures based on an increased environmental complexity (globalization and competition of regions, regionalization of action, insufficient institutional reforms, change of political structures (europeanization), demographic change, financial condition of municipality and necessity of efficient task fulfillment). (Maier *et al.* 2006, p 143)

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relations are not lockable. Each even minimal extension of the temporal horizon multiplies the number of causes and caused outcomes. Furthermore also not-occurring events have to be involved as possible causes. (Luhmann 2000, pp 402-403) Even worse within the definition of causal relations there are so-called time lags. These are internal delays due to time consumption for diagnosis of problems as well as delays of action, implementation, and enforcement. However the attribution of politics regarding causality is expedient, because of its motivation function. In that the causation constitutes the motivation of the controlling action. The outcome has to be accounted for, as far as it belongs to the intention. (Luhmann 2000, pp 23-25)

As mentioned before politics do not possess **instruments of enforcement of claims** against other subsystems. Merely politics is indirectly able to induce other systems to react towards own efforts of controlling. Whether and how attempts of regulation are perceived of the economic system, depends on its resonance ability. Since a system's environment is always more complex than the system itself, each system reduces the environmental complexity by selective reaction towards disturbances. (Luhmann 1990, pp 33-35) The resonance is defined by its system specific operations, i.e. code and programs. Only if environmental data get through this 'double filter', they gain relevance system internally. Information comes into existence only by the system internal differentiation of the data available in the environment (relevant or irrelevant). Without system immanent operations there are only facts, but no information. I.e. information is a system internal quality. (Luhmann 1990, pp 40-46) The economic system is based on the medium of communication money. The specific code is payment/non-payment. The political system is based on the medium of communication power. Its application serves for the enforcement of socially binding decisions and therefore the stabilization of social structures. Hence, politics and economy code their contents of communication differently.

As a conclusion it can be argued that following the system theory a regulation from outside, a regulation in terms of hierarchical meaning, is not feasible. This based on the operational closeness und the self-relation of functional differentiated subsystems. This leads to the impossibility of application of action theories (German: *Handlungstheorie*) (Wiesenthal 2006, pp 32-34)

Being skeptical towards controlling Luhmann does not deny the necessity of political intervention, even it is not or only hardly promising. The reason is that the society as a whole is not capable to answer towards environmental hazard. An answer arises only out of limitations of options of its subsystems. (Luhmann 1990, pp 47-50) The dilemma of politics is the inability to regulate economic processes as well as increasing expectations and attribution of responsibility towards politics. This leads the political system to its limits of performance, since its competence of intervention fails at the point of the functions of the other subsystems, their codes and programs. (Wiesenthal 2006, pp 68-69)

#### **4. Revision of the term of controlling and regulation**

Politics ought to rebalance existing performance insufficiencies of other functional systems. Yet it has to account for the autonomy of the other systems and has to use its competence to intervene carefully. Following Ulrich politics features a 'competence of compensation of incompetence' and only has to intervene if the reproduction of the whole issue is at risk. (Ulrich 1994, pp 150-152) The actions theory which is widely used in politics regards controlling basically as an action (of controlling) and relies on ability and willingness of

individuals. But from a system theory's viewpoint a revision of the term of controlling and regulation is needed. It is now not the same as interventionism, i.e. it is not related to a particular case targeting a precise outcome. (Ulrich 1994, pp 84) Accordant to system theory the controlling is the attempt to influence the communication process of a system for the main part. Thus, the system theory's expectation towards political controlling is substantially more modest than those of interventionist approaches. (Bode 1999, pp 207-208) But which kind of communication will be perceived by the EIP system? What approaches of an irritation of the EIP-system are available to politics? What are the options for politics to translate their calls for a more socially and environmentally compatible park design into the language of the EIP system?

In the first instance controlling in terms of system theory is always **self controlling**. Determined by the system specific way of operating the system produces and reproduces its own elements and structures. Controlling is a form of spontaneous generating of order related to system internal conditions. This thought is hardly new. Within the economic construct of ideas the market takes over peripherally and non-intentionally the social controlling. (Ulrich 1994, p 85) As a consequence of this interpretation of controlling: Controlling is only successful if in both the controlling system and the controlled system the operations of controlling are integrated in the operations of autopoiesis. The influential system has to be geared to specific objectives and instruments that apply only within the controlled system. (Ulrich 1994, p 92)

Politics cannot promote sustainable economic activity, but merely influence the communication of the economic system. Therefore the issue of environmental hazard has to be broached, i.e. to be perceived and to be classified as relevant. As long as it is not communicated about ecologic hazard, it is not existent for the system. (Egner 2006, p 70) But how can politics produce a communication on ecologic hazard in the economic system? The issues of communication are caused by the systems' **ability of resonance**. This is not about real matters of fact, but about the perception of the system related to its environment. A resonance towards environmental hazard within the economic subsystem can be reached only by system's own operations. (Luhmann 1990, pp 62–65) All social subsystem are able to put into effect disruptions of other systems. They possibly bring about the other system to a reaction. The rationale is based on the fact that systems are not exclusively specialized for certain categories of occurrences. Rather basically any kind of occurrence can be observed by any system. Due to system immanent modes of operation the event has to be transformed into information for the system with the help of the leading difference. Only then internal options of junction are produced. Resonance describes a process in which the system drifts from its closure towards its environment as well as let itself irritate only in exceptional cases. (Bode 1999, pp 222-223)

The difference of code and program is significant for the theory of controlling in Luhmann's tradition. Codes are invariant, whereas programs can be modified within the limitations given by the code. **Programs** describe objectives within the operational context of the system; accordant their proportion the state of system should be approximated. This is also called 'programs of difference reduction' (German: *Differenzminderungsprogramme*). The economic subsystem uses economic programs, politics only political programs. Nevertheless, it is the objective of politics to influence economic programs of difference reduction. Politics are also capable to produce conditions, which affect economic programs. Generally politics try to intervene into the attraction of economic programs. (Luhmann 1994, pp 346-347) For this environment problems have to be highlighted as costs. Examples for political capabilities

of intervention are the creation of new markets and new options for income, creation of buying incitements, non-productive payments or the production of ability to pay. The advantage of the focus on prices is that problems which are expressed in such a way *are* to be processed in the EIP system. (Luhmann 1990, pp 101–123)

For reduction of complexity systems concentrate not on the entire environment but explicitly on different systems in environment. Relations to the environment are mainly **inter-systemic relations**. Society is differentiated in various subsystems indeed. However by application of a generalized medium the inclusion of all social subsystems is feasible anyhow.

As it is known all subsystems work on the basis of actualization of meaning by application of language. For this reason relations between social systems are closer than relations to the environment. Communications between subsystems is feasible, even if they are based on different codes. Thus disruptions of the economic system by the political system are much more likely than irritation by extra-societal environment. Moreover subsystems are irritable because they are differentiated for certain services. With that it is very likely that turbulences of one subsystem spread to another. (Brodocz 2003, p 82; Luhmann 1990, pp 218–226)

Continuous irritation by one subsystem may lead to regularity in system reactions. This is also called **structural coupling**, which is defined as a coupling *of* two systems and rather than *between* two systems. The coupling is to be understood structurally rather than operatively. The structure of systems arises from expectations, more precisely, from their disappointment or fulfillment. Structural coupling is an institution on which both systems limit their expectations in relation to the accordingly other system. An event that deviates from the expectation is conspicuous as an irritation. By establishment of expectations all irritations of the other system are ignored, which are not object of the expectation. Thus, there is an indifference towards other irritations of the coupled system. Structural coupling irritates the cognitive processes of a system, but it does not determine them. (Brodocz 2003, p 83) Consequently an exertion of influence of the political system towards the EIP system is feasible also in narrow confines of resonance. Controlling occurs with the help of intended creation of disturbance. In the process systems adjust themselves to the disturbance, and for complete structural coupling also in a way of anticipation. Here the temporality of structural coupling is to be paid regard, which leads to instability. Controlling is ineffective, when patterns of reaction already have changed whereas the same way of controlling is applied. Hence a theory of controlling has to pay regard to the dynamics of reaction patterns. Future prospects of modified conditions of controlling are excluded. Following the concept of autopoieses there is no permanent structural coupling, but it offers options of controlling regularly. (Bode 1999, pp 224-227)

Another possibility for an impact between functional subsystems is **participation**. The controlling system exposes itself to the communication context of the controlled system. Whose communication will not be determined entirely, but influenced substantially. Hence economics will be controlled from outside by application of economics. The government avail itself by the leading difference pay/not to pay. The precondition for this interpenetration is the ability of the controlling system to apply this scheme of differentiation, while the own identity is conserved. If the system loses its identity, it stops existing. The ability of multilinguality is not possible for functional systems. Psychic systems are able to articulate their interests also in other systems. Also organizations are characterized by multilinguality. Even if organizational systems are apparently assigned to a functional system, they participate in other systems at the same time. Casually a modification of communication content is unavoidable. (Bode 1999, pp 220-221) Certainly it still has to be analyzed, to what extent the

fact that an EIP is an organizational system, which processes economic, judicial, political communications, can be used for a political manipulation of an EIP development.

## **5. Conclusion**

The concept of EIPs includes ecologic and economic benefits from a theoretical point of view. However, in practical application frequently they are not materialized entirely. Thus rather the local abutters profit from surpluses, but not the further region. If politics intends to exploit the concept of EIP as an instrument of regional development, an intervention in the process is needed. The present study has analyzed to what extent political control for an EIP-development is feasible, by application of Niklas Luhmann's system theory.

From the system theory's viewpoint the following can be stated: A direct intervention in the development of EIP by politics is not feasible, but rather through a targeted causation of irritations of the EIP-system. In terms of system theory an external controlling is to be regarded as a generating of conditions for the accordant system, in order to arrange the system internal information processing, so that an internal coordination of behavior leads to the desired changes. With that political controlling bears in mind two interactional processes: First, the communication between political and economic system, secondly autonomic intrasystemic operational process. So, it ought to be the objective, to cause impulses, which are perceptible, urging for action and not rejecting for the targeted system.

To build up cooperative structures and thus for gaining compound surpluses for the region there is not necessarily need for more and more detailed information. Sustainability-related policy is promising, if it acts by using system adequate instruments. (Egner 2006, p 165) Regarding EIPs as part of the economic system and therefore as autopoiesis of paying, money difference is what matters. (Luhmann 1994, p 343) These considerations lead to the following thesis: A regulative framework is needed for a sustainable development in industrial parks. However, an actual improvement of environmental performance of EIPs is accomplishable rather by economic incentives. Which instruments of environmental policy are efficient/effective (moral appeal, governmental and collective provision, taxes and duties, subsidies, traded property rights) is to get cleared up in further research.

## Reference list

- Bode, Otto F. (1999): Systemtheoretische Überlegungen zum Verhältnis von Wirtschaft und Politik: Luhmanns Autopoiesiskonzept und seine exemplarische Anwendung auf Fragen wirtschaftspolitischer Steuerungsmöglichkeiten. Marburg, Metropolis-Verlag.
- Brodocz, André (2003): Das politische System und seine strukturelle Kopplung. In: Hellmann, Kai-Uwe; Fischer, Karsten; Bluhm, Harald (Hrsg.): Das System der Politik. Niklas Luhmanns politische Theorie. Wiesbaden, Westdeutscher Verlag.
- Egner, Heike (2008): Gesellschaft, Mensch, Umwelt - beobachtet. Ein Beitrag zur Theorie der Geographie, Stuttgart, Franz Steiner Verlag.
- Görlitz, Axel; Adam, Silke (2003): „Strukturelle Kopplung“ als Steuerungstheorie: Rekonstruktion und Kritik. In: Hellmann, Kai-Uwe; Fischer, Karsten; Bluhm, Harald (Hrsg.): Das System der Politik. Niklas Luhmanns politische Theorie. Wiesbaden, Westdeutscher Verlag.
- Hutt, Carsten Frank (2007): Neue Konzepte der Kommunalen Wirtschaftsförderung. Die Konzeption für den Aufbau eines Medien- und IT-Clusters am Südlichen Oberrhein. Freiburg, Fakultät der Albert-Ludwigs-Universität Freiburg. Dissertation.
- Kneer, Georg; Nassehi, Armin (2000): Niklas Luhmanns Theorie sozialer Systeme: Eine Einführung. 4. Aufl. München, UTB für Wissenschaft.
- Luhmann, Niklas (2000): Soziale Systeme: Grundriß einer allgemeinen Theorie. Frankfurt am Main, Suhrkamp Verlag.
- Luhmann, Niklas (1998): Die Gesellschaft der Gesellschaft. Teilband 1. 8. Aufl. Frankfurt am Main, Suhrkamp Verlag.
- Luhmann, Niklas (1994): Die Wirtschaft der Gesellschaft. Frankfurt am Main, Suhrkamp Verlag.
- Luhmann, Niklas (1990): Ökologische Kommunikation. Kann die moderne Gesellschaft sich auf ökologische Gefährdung einstellen? 3. Aufl. Opladen, Westdeutscher Verlag.
- Maier, Gunther; Tödtling, Franz; Trippl, Michaela (2006a): Regional- und Stadtökonomik 2. Regionalentwicklung und Regionalpolitik. 3. Aufl. Wien et al., Springer.
- McManus, Phil; Gibbs, David (2008): Industrial ecosystems? The use of tropes in the literature of industrial ecology and eco-industrial parks. In: Progress in Human Geography 32(4). pp. 525–540.
- Staudacher, Christian (2005): Wirtschaftsgeographie regionaler Systeme. Wien, WUV-Universitäts-Verlag.
- Sterr, Thomas; Ott, Thomas (2004): The Industrial Region as a Promising Unit for Eco-Industrial Development – Reflections, Practical Experience and the Establishment of Innovative Instruments to Support Industrial Ecology. In: Jouni Korhonen; Don Huisingh; Anthony S.F. Chiu (Eds.): Journal of Cleaner Production. Special Issue: Applications of Industrial Ecology. Vol. 12 /8-10, pp. 945-967.
- Ulrich, Günter (1994): Politische Steuerung. Staatliche Intervention aus systemtheoretischer Sicht. Opladen, Leske und Budrich.

Wiesenthal, Helmut (2006): Gesellschaftssteuerung und gesellschaftliche Selbststeuerung: Eine Einführung. VS Verlag für Sozialwissenschaften.



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**Track:** 5c Regional sustainability: economic development and industrial symbiosis

**Title of the paper:** **Eco-Industrial Parks as an instrument for regional sustainable development – a system theoretical approach**

**Form of presentation:** poster

**Abstract**

*Just like industrial agglomerations in general, industrial parks exhibit a substantial ecological burden for their surrounding environment. The concept of Eco-Industrial Parks (EIP) pursues the objective of minimizing these environmental impacts. Public authorities are highly interested in the development of EIPs and are widely willing to support corresponding developments. However, a comprehensive implementation of the idea of EIPs has not been accomplished so far. It is the idea of this research project to analyse the relation between the politic and the EIPs by means of Niklas Luhmann's theory of social systems. By applying this approach it is possible to understand structures, impacts, and evolutionary mechanisms within an EIP as well as its relations to the environment and the political system. From a viewpoint of practical application the survey may support regional and municipal policies by providing recommendations for the promotion of EIPs (and therefore for an efficient allocation of funds). According to Luhmann, social systems are operatively closed and basically not controllable from outside. However, in exceptional cases a system might be irritated by its environment. The questions which could be answered by the system theory are: Which kind of communication will be perceived by the EIP system? What approaches of an irritation of the EIP-system are available to politics? What are the options for politics to translate their calls for a more socially and environmentally compatible park design into the language of the EIP system?*

## 1. Eco-industrial Parks and the necessity of political regulation

The concept of Eco-Industrial Parks (EIP) aims at both, improving the environmental performance of industrial agglomerations and gaining economic benefits. More precisely, with the aid of EIPs the input of resources and energy is intended to be minimised and the idea of recycling management should be implemented. Therefore the conventional industrial park is extended by environmentally compatible infrastructure and technologies. The foundations of a practical success of EIPs are a regionally minimal distance and a actors' willingness to cooperate. From their viewpoint an EIP offers potentially economic benefit such as advantages of localisation and urbanisation. (Sterr/Ott 2004, pp 955-956)

To what extent the EIP concept is advantageous for the region, depends not least on the stakeholder's depth of cooperation. In principle each industrial enterprise's settlement generates an **investment surplus**, i.e. a sustainment, extension resp. improvement of production potential by input of capital goods. The scope of this effect though is regionally limited. Cooperative relations are no precondition for gaining the investment surplus. Likewise no cooperation is required for a **neighbour ship surplus**, through a so-called passive integration of location. With it the attraction of location is affected based on field of externalities. Both, the investment surplus and neighbourhood surplus, are no exclusive feature of EIPs, but are also features of conventional industrial parks and other industrial agglomerations. However, an intentional local and systematic integration are distinctive features of EIPs, since they are based on cooperation of actors among themselves and with regional stakeholders. The local integration derives from division of labour and specialisation and it covers all processes of interaction and exchange. By patterns of networking and action secondary local features are generated, which then again give other accounting entities utility possibilities of the location and the further region (so-called **regional effects**). But only through system integration actual organisational systems emerge by networks and cooperation. Positive effect of those systems is the **compound surplus**. Preconditions for such a competitive edge are adequate structures of communication. (Staudacher 2005, pp 95–97).

In practice frequently only a low impact level is attained. Actual compound surpluses are gained only occasionally. Politics already gives support to EIP by subsidies, consulting services or the like, because they are considered as an instrument for sustainable regional development. Such interventions are legitimated with arguments of environmental and economic policy. But even if an intervention is reasonable from the society's viewpoint, the question remains whether and how a political controlling can succeed in the effort to gain compound surpluses.

This is the issue which will be investigated in the present paper. It is the idea of the study to analyse the capability of politics of controlling the development of EIPs, with the aid of the system theory of Niklas Luhmann. By the application of this approach it is possible, to better understand the relation of politics and economy (which also EIPs belong to) and therefore to highlight the scope of action of political controlling. It is the objective of the project to examine the following aspects: The question of control mechanisms; and subsequently an evaluation of possible intervention by regional policy. From a viewpoint of practical application the survey may support regional and municipal policies by providing recommendations for the promotion of EIPs (and therefore for an efficient allocation of funds).

The study is designed as a theoretical inquiry. Thus, in the first instance it is not intended to make recommendations for a certain concrete industrial park. Rather general ideas and conclusions concerning EIPs, including their significance for their surrounding region as well as results with regard to their controllability by public authorities will be discussed.

## **2. System theory and its application**

The distinctiveness of Niklas Luhmann's system theory in compared to other social theories arises from its non-constrained socialisation. The considered object is, unlike classical sociology, not the individual and its actions. Following Luhmann the system of society as well as its operational mode and dynamic of development can only be understood and explained by turning away from activeness of human beings and their physiological and psychological factors. (Görlitz/Adam 2003, p 284) In terms of system theory society consists of operations, more precisely: of communication. This perception is contrary to almost the entire sociological and philosophical tradition. (Kneer/Nassehi 2000, pp 65-68).

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relations are not lockable. Each even minimal extension of the temporal horizon multiplies the number of causes and caused outcomes. Furthermore also not-occurring events have to be involved as possible causes. (Luhmann 2000, pp 402-403) Even worse within the definition of causal relations there are so-called time lags. These are internal delays due to time consumption for diagnosis of problems as well as delays of action, implementation, and enforcement. However the attribution of politics regarding causality is expedient, because of its motivation function. In that the causation constitutes the motivation of the controlling action. The outcome has to be accounted for, as far as it belongs to the intention. (Luhmann 2000, pp 23-25)

As mentioned before politics do not possess **instruments of enforcement of claims** against other subsystems. Merely politics is indirectly able to induce other systems to react towards own efforts of controlling. Whether and how attempts of regulation are perceived of the economic system, depends on its resonance ability. Since a system's environment is always more complex than the system itself, each system reduces the environmental complexity by selective reaction towards disturbances. (Luhmann 1990, pp 33-35) The resonance is defined by its system specific operations, i.e. code and programs. Only if environmental data get through this 'double filter', they gain relevance system internally. Information comes into existence only by the system internal differentiation of the data available in the environment (relevant or irrelevant). Without system immanent operations there are only facts, but no information. I.e. information is a system internal quality. (Luhmann 1990, pp 40-46) The economic system is based on the medium of communication money. The specific code is payment/non-payment. The political system is based on the medium of communication power. Its application serves for the enforcement of socially binding decisions and therefore the stabilization of social structures. Hence, politics and economy code their contents of communication differently.

As a conclusion it can be argued that following the system theory a regulation from outside, a regulation in terms of hierarchical meaning, is not feasible. This based on the operational closeness und the self-relation of functional differentiated subsystems. This leads to the impossibility of application of action theories (German: *Handlungstheorie*) (Wiesenthal 2006, pp 32-34)

Being skeptical towards controlling Luhmann does not deny the necessity of political intervention, even it is not or only hardly promising. The reason is that the society as a whole is not capable to answer towards environmental hazard. An answer arises only out of limitations of options of its subsystems. (Luhmann 1990, pp 47-50) The dilemma of politics is the inability to regulate economic processes as well as increasing expectations and attribution of responsibility towards politics. This leads the political system to its limits of performance, since its competence of intervention fails at the point of the functions of the other subsystems, their codes and programs. (Wiesenthal 2006, pp 68-69)

#### **4. Revision of the term of controlling and regulation**

Politics ought to rebalance existing performance insufficiencies of other functional systems. Yet it has to account for the autonomy of the other systems and has to use its competence to intervene carefully. Following Ulrich politics features a 'competence of compensation of incompetence' and only has to intervene if the reproduction of the whole issue is at risk. (Ulrich 1994, pp 150-152) The actions theory which is widely used in politics regards controlling basically as an action (of controlling) and relies on ability and willingness of

individuals. But from a system theory's viewpoint a revision of the term of controlling and regulation is needed. It is now not the same as interventionism, i.e. it is not related to a particular case targeting a precise outcome. (Ulrich 1994, pp 84) Accordant to system theory the controlling is the attempt to influence the communication process of a system for the main part. Thus, the system theory's expectation towards political controlling is substantially more modest than those of interventionist approaches. (Bode 1999, pp 207-208) But which kind of communication will be perceived by the EIP system? What approaches of an irritation of the EIP-system are available to politics? What are the options for politics to translate their calls for a more socially and environmentally compatible park design into the language of the EIP system?

In the first instance controlling in terms of system theory is always **self controlling**. Determined by the system specific way of operating the system produces and reproduces its own elements and structures. Controlling is a form of spontaneous generating of order related to system internal conditions. This thought is hardly new. Within the economic construct of ideas the market takes over peripherally and non-intentionally the social controlling. (Ulrich 1994, p 85) As a consequence of this interpretation of controlling: Controlling is only successful if in both the controlling system and the controlled system the operations of controlling are integrated in the operations of autopoiesis. The influential system has to be geared to specific objectives and instruments that apply only within the controlled system. (Ulrich 1994, p 92)

Politics cannot promote sustainable economic activity, but merely influence the communication of the economic system. Therefore the issue of environmental hazard has to be broached, i.e. to be perceived and to be classified as relevant. As long as it is not communicated about ecologic hazard, it is not existent for the system. (Egner 2006, p 70) But how can politics produce a communication on ecologic hazard in the economic system? The issues of communication are caused by the systems' **ability of resonance**. This is not about real matters of fact, but about the perception of the system related to its environment. A resonance towards environmental hazard within the economic subsystem can be reached only by system's own operations. (Luhmann 1990, pp 62–65) All social subsystem are able to put into effect disruptions of other systems. They possibly bring about the other system to a reaction. The rationale is based on the fact that systems are not exclusively specialized for certain categories of occurrences. Rather basically any kind of occurrence can be observed by any system. Due to system immanent modes of operation the event has to be transformed into information for the system with the help of the leading difference. Only then internal options of junction are produced. Resonance describes a process in which the system drifts from its closure towards its environment as well as let itself irritate only in exceptional cases. (Bode 1999, pp 222-223)

The difference of code and program is significant for the theory of controlling in Luhmann's tradition. Codes are invariant, whereas programs can be modified within the limitations given by the code. **Programs** describe objectives within the operational context of the system; accordant their proportion the state of system should be approximated. This is also called 'programs of difference reduction' (German: *Differenzminderungsprogramme*). The economic subsystem uses economic programs, politics only political programs. Nevertheless, it is the objective of politics to influence economic programs of difference reduction. Politics are also capable to produce conditions, which affect economic programs. Generally politics try to intervene into the attraction of economic programs. (Luhmann 1994, pp 346-347) For this environment problems have to be highlighted as costs. Examples for political capabilities

of intervention are the creation of new markets and new options for income, creation of buying incitements, non-productive payments or the production of ability to pay. The advantage of the focus on prices is that problems which are expressed in such a way *are* to be processed in the EIP system. (Luhmann 1990, pp 101–123)

For reduction of complexity systems concentrate not on the entire environment but explicitly on different systems in environment. Relations to the environment are mainly **inter-systemic relations**. Society is differentiated in various subsystems indeed. However by application of a generalized medium the inclusion of all social subsystems is feasible anyhow.

As it is known all subsystems work on the basis of actualization of meaning by application of language. For this reason relations between social systems are closer than relations to the environment. Communications between subsystems is feasible, even if they are based on different codes. Thus disruptions of the economic system by the political system are much more likely than irritation by extra-societal environment. Moreover subsystems are irritable because they are differentiated for certain services. With that it is very likely that turbulences of one subsystem spread to another. (Brodocz 2003, p 82; Luhmann 1990, pp 218–226)

Continuous irritation by one subsystem may lead to regularity in system reactions. This is also called **structural coupling**, which is defined as a coupling *of* two systems and rather than *between* two systems. The coupling is to be understood structurally rather than operatively. The structure of systems arises from expectations, more precisely, from their disappointment or fulfillment. Structural coupling is an institution on which both systems limit their expectations in relation to the accordingly other system. An event that deviates from the expectation is conspicuous as an irritation. By establishment of expectations all irritations of the other system are ignored, which are not object of the expectation. Thus, there is an indifference towards other irritations of the coupled system. Structural coupling irritates the cognitive processes of a system, but it does not determine them. (Brodocz 2003, p 83) Consequently an exertion of influence of the political system towards the EIP system is feasible also in narrow confines of resonance. Controlling occurs with the help of intended creation of disturbance. In the process systems adjust themselves to the disturbance, and for complete structural coupling also in a way of anticipation. Here the temporality of structural coupling is to be paid regard, which leads to instability. Controlling is ineffective, when patterns of reaction already have changed whereas the same way of controlling is applied. Hence a theory of controlling has to pay regard to the dynamics of reaction patterns. Future prospects of modified conditions of controlling are excluded. Following the concept of autopoieses there is no permanent structural coupling, but it offers options of controlling regularly. (Bode 1999, pp 224-227)

Another possibility for an impact between functional subsystems is **participation**. The controlling system exposes itself to the communication context of the controlled system. Whose communication will not be determined entirely, but influenced substantially. Hence economics will be controlled from outside by application of economics. The government avail itself by the leading difference pay/not to pay. The precondition for this interpenetration is the ability of the controlling system to apply this scheme of differentiation, while the own identity is conserved. If the system loses its identity, it stops existing. The ability of multilinguality is not possible for functional systems. Psychic systems are able to articulate their interests also in other systems. Also organizations are characterized by multilinguality. Even if organizational systems are apparently assigned to a functional system, they participate in other systems at the same time. Casually a modification of communication content is unavoidable. (Bode 1999, pp 220-221) Certainly it still has to be analyzed, to what extent the

fact that an EIP is an organizational system, which processes economic, judicial, political communications, can be used for a political manipulation of an EIP development.

## **5. Conclusion**

The concept of EIPs includes ecologic and economic benefits from a theoretical point of view. However, in practical application frequently they are not materialized entirely. Thus rather the local abutters profit from surpluses, but not the further region. If politics intends to exploit the concept of EIP as an instrument of regional development, an intervention in the process is needed. The present study has analyzed to what extent political control for an EIP-development is feasible, by application of Niklas Luhmann's system theory.

From the system theory's viewpoint the following can be stated: A direct intervention in the development of EIP by politics is not feasible, but rather through a targeted causation of irritations of the EIP-system. In terms of system theory an external controlling is to be regarded as a generating of conditions for the accordant system, in order to arrange the system internal information processing, so that an internal coordination of behavior leads to the desired changes. With that political controlling bears in mind two interactional processes: First, the communication between political and economic system, secondly autonomic intrasystemic operational process. So, it ought to be the objective, to cause impulses, which are perceptible, urging for action and not rejecting for the targeted system.

To build up cooperative structures and thus for gaining compound surpluses for the region there is not necessarily need for more and more detailed information. Sustainability-related policy is promising, if it acts by using system adequate instruments. (Egner 2006, p 165) Regarding EIPs as part of the economic system and therefore as autopoiesis of paying, money difference is what matters. (Luhmann 1994, p 343) These considerations lead to the following thesis: A regulative framework is needed for a sustainable development in industrial parks. However, an actual improvement of environmental performance of EIPs is accomplishable rather by economic incentives. Which instruments of environmental policy are efficient/effective (moral appeal, governmental and collective provision, taxes and duties, subsidies, traded property rights) is to get cleared up in further research.



## Reference list

- Bode, Otto F. (1999): Systemtheoretische Überlegungen zum Verhältnis von Wirtschaft und Politik: Luhmanns Autopoiesiskonzept und seine exemplarische Anwendung auf Fragen wirtschaftspolitischer Steuerungsmöglichkeiten. Marburg, Metropolis-Verlag.
- Brodocz, André (2003): Das politische System und seine strukturelle Kopplung. In: Hellmann, Kai-Uwe; Fischer, Karsten; Bluhm, Harald (Hrsg.): Das System der Politik. Niklas Luhmanns politische Theorie. Wiesbaden, Westdeutscher Verlag.
- Egner, Heike (2008): Gesellschaft, Mensch, Umwelt - beobachtet. Ein Beitrag zur Theorie der Geographie, Stuttgart, Franz Steiner Verlag.
- Görlitz, Axel; Adam, Silke (2003): „Strukturelle Kopplung“ als Steuerungstheorie: Rekonstruktion und Kritik. In: Hellmann, Kai-Uwe; Fischer, Karsten; Bluhm, Harald (Hrsg.): Das System der Politik. Niklas Luhmanns politische Theorie. Wiesbaden, Westdeutscher Verlag.
- Hutt, Carsten Frank (2007): Neue Konzepte der Kommunalen Wirtschaftsförderung. Die Konzeption für den Aufbau eines Medien- und IT-Clusters am Südlichen Oberrhein. Freiburg, Fakultät der Albert-Ludwigs-Universität Freiburg. Dissertation.
- Kneer, Georg; Nassehi, Armin (2000): Niklas Luhmanns Theorie sozialer Systeme: Eine Einführung. 4. Aufl. München, UTB für Wissenschaft.
- Luhmann, Niklas (2000): Soziale Systeme: Grundriß einer allgemeinen Theorie. Frankfurt am Main, Suhrkamp Verlag.
- Luhmann, Niklas (1998): Die Gesellschaft der Gesellschaft. Teilband 1. 8. Aufl. Frankfurt am Main, Suhrkamp Verlag.
- Luhmann, Niklas (1994): Die Wirtschaft der Gesellschaft. Frankfurt am Main, Suhrkamp Verlag.
- Luhmann, Niklas (1990): Ökologische Kommunikation. Kann die moderne Gesellschaft sich auf ökologische Gefährdung einstellen? 3. Aufl. Opladen, Westdeutscher Verlag.
- Maier, Gunther; Tödtling, Franz; Trippl, Michaela (2006a): Regional- und Stadtökonomik 2. Regionalentwicklung und Regionalpolitik. 3. Aufl. Wien et al., Springer.
- McManus, Phil; Gibbs, David (2008): Industrial ecosystems? The use of tropes in the literature of industrial ecology and eco-industrial parks. In: Progress in Human Geography 32(4). pp. 525–540.
- Staudacher, Christian (2005): Wirtschaftsgeographie regionaler Systeme. Wien, WUV-Universitäts-Verlag.
- Sterr, Thomas; Ott, Thomas (2004): The Industrial Region as a Promising Unit for Eco-Industrial Development – Reflections, Practical Experience and the Establishment of Innovative Instruments to Support Industrial Ecology. In: Jouni Korhonen; Don Huisingh; Anthony S.F. Chiu (Eds.): Journal of Cleaner Production. Special Issue: Applications of Industrial Ecology. Vol. 12 /8-10, pp. 945-967.
- Ulrich, Günter (1994): Politische Steuerung. Staatliche Intervention aus systemtheoretischer Sicht. Opladen, Leske und Budrich.

Wiesenthal, Helmut (2006): Gesellschaftssteuerung und gesellschaftliche Selbststeuerung: Eine Einführung. VS Verlag für Sozialwissenschaften.

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**Track 5c:** Regional sustainability: economic development and industrial symbiosis

### **‘Working with the Neighbours’: Application of industrial ecology across port areas and its potential to leverage commercial advantage and support sustainable development**

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### **Abstract**

Ports and their related industrial and amenity areas are critical economic and social components in their region. As hubs for industry, business, leisure and logistics they are also resource intensive and can pose environmental challenges.

In the Netherlands ports are vital to the national economy. Faced with increasing growth, limited space and ever tightening environmental constraints, innovative collaborative solutions have had to be developed to support port areas’ intensification. The introduction of industrial ecology (IE) principles and industrial symbiosis (IS) practices, including utility sharing and beneficial use of residual resources, has made a valuable contribution to improving resource efficiency. Often facilitated by the local business association working with the Port Authority, these practices are becoming part of every day management. Industrial ecology is now considered as an important tool for sustainable port area development.

Such collaboration is not evident across port areas in the UK. The goal of this research project was to establish whether the application of IE principles, and IS and co-operative planning in particular, across UK and South West England’s port areas, could be beneficial and help leverage competitive advantage and sustainable development?

The research project was supported by the University of Surrey (Centre for Environmental Strategy), the UK’s National Industrial Symbiosis Programme (NISP), the South West Regional Development Agency (SWRDA) and the South West Regional Ports Association (SWRPA).

An extensive literature review was undertaken and a framework for identifying IE drivers, enablers and barriers was developed. This has been applied and tested against experience from Dutch ports, and from findings from a detailed study of twenty South West port operations. In addition to providing information on the (relative) potential for resource efficiency through IE in

these areas, the work has demonstrated the value of the framework as a tool for assessing the potential for IE that can be applied more generally. In parallel, a demonstration project has been undertaken focussing on the Bristol port area. This has also informed the assessment of the potential for and value of IE across port areas.

Among other findings, this study indicates that there are potential opportunities for the application of IE across port areas generally, and in the South West of England particularly across port areas such as Bristol, Falmouth, Portland and Plymouth. Drivers include the need for cost reduction and decarbonisation. Investment would be required in ongoing facilitation and building social cohesion, supporting the development of networks and raising awareness. Complementary policy drivers and enablers are also required and some initial thoughts on these have been developed.

This study has contributed to the international body of research on and practical application of IE across port areas, and, in the UK context, is the first to focus on South West England. Recommendations to disseminate the findings more widely across the SW England port industry, and beyond, will be further developed during 2012. Due to the central role of regional associations, it is recommended that opportunities be explored with the South West Regional Ports Association for promoting regional co-operation. Given the value of having practical demonstration projects to promote stakeholder engagement and resource efficiency benefits, it is suggested that initiatives be developed across other port areas such as Falmouth and Plymouth which have been indicated as having potential for improved resource efficiency through IE. Embedding IE thinking into area wide planning has also been shown to have value and it is suggested that research is undertaken to examine its application to support the developing field of port master planning.

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## 1 Introduction

Ports and their related industrial and amenity areas are critical economic and social components in their region. As hubs for industry, business, leisure and logistics they are also resource intensive and can pose environmental challenges.

In the Netherlands ports are vital to the national economy. Faced with increasing growth, limited space and ever tightening environmental constraints there was a need to find innovative collaborative solutions to support port areas' intensification. What sort of solutions? Could industrial ecology provide an answer?

### Industrial ecology thinking

Industrial ecology (IE) is built upon the founding premise that industrial systems can mimic natural systems, and reduce their impact on, and increase their harmony with, the natural environment. In natural systems materials are part of closed cycles. Industrial ecology seeks to take a 'systematic' approach to the 'management of materials and energy flows through the human economy, including beneficial use of waste' [1,p434]. Utilising waste from one process as an input to another supports a change from open or linear processes to closed or cyclical processes [2]. Where this cascading of materials or energy is achieved through collaborative relationships between normally unrelated industries, it is referred to as industrial symbiosis (IS). This is a key IE strategy. There are many examples where IS has been successfully utilised by co-located industries. The most renowned example is in Kalundborg in Denmark.

### IE and Dutch ports

The introduction of IE principles and IS practices has made a valuable contribution to improving resource efficiency across Dutch ports. Often facilitated by the local business association working with the Port Authority (PA), these practices are becoming part of every day management. IE is now an important tool for sustainable port area development.

### The UK experience

Such collaboration is not evident across port areas in the UK. The goal of this research was to establish whether the application of IE principles could be beneficial and help leverage competitive advantage and sustainable development.

### The research project

The research project was undertaken from 2008 to 2011 supported by the University of Surrey (Centre for Environmental Strategy), the UK's National Industrial Symbiosis Programme (NISP) and the South West Regional Ports Association (SWRPA). An associated demonstration project across The Bristol Port estate and its vicinity is ongoing.

The project's aims were to understand the drivers, barriers and enablers for IE across ports in the Netherlands, how they had been overcome and built upon, and whether the same conditions were

present in the UK. If this were the case, could IE be more widely adopted, and how, and if not were there still opportunities for its beneficial application.

A combination of literature reviews and empirical research including unstructured interviews and discussions were undertaken. IE drivers, barriers and enablers were researched, a framework for their identification developed, applied and tested against experience from Dutch ports.

An understanding was also developed of the structure and nature of ports in the Netherlands, UK and South West England.

Discussions with UK port stakeholders were further informed by findings from a detailed study of twenty South West port operations and a comparative analysis undertaken between Dutch and UK practice and potential.

This paper provides a summary of the research undertaken, its results and recommendations. The development and evolution of IE across port areas in The Netherlands is presented in more detail. This is followed by an introduction into the UK research, the comparative analysis between the UK and the Netherlands and implications for the UK.

## 2 Industrial Ecology Enablers, Drivers and Barriers

The development of IE is influenced by a number of factors, identified through the literature review. These were grouped into categories shown in table 1, synthesised from the overlapping categorisations developed by Brand and de Bruijn [4], Mirata [5] and Sakr et al [6]. These were used to categorise the drivers, enablers and barriers identified by the research.

**Table 1: Categories of drivers, enablers & barriers identified**

Category	Description
Motivational	Developing a social network between businesses and organisations; encouraging broad participation; developing co-operation and trust
Economic	Evaluating the business case for interactions between organisations
Informational	Providing information between parties to develop awareness; identifying opportunities
Regulatory	Considering policy and regulatory factors and the impact of authorities
Technical	Understanding the technical feasibility for interactions between organisations
Other	Considering other important factors not included elsewhere

The motivational factors appeared to dominate and were considered as most important. They work to create willingness to co-operate and engage.

Sakr et al [6] cite economic value added as the second most important factor in developing successful synergies. All the literature sources reviewed agree that **economic benefit** and a **convincing business case** are key enablers.

The informational factors provide the building blocks from which assessments can be made and information exchanged. They are about trying to avoid what Kincaid and Overcash [7] identified as ‘**happenstance**’ (p118) i.e. finding out about opportunities to exchange resources in a systematic way rather than stumbling across them.

Government at all levels has an important role to play through regulatory factors as a driver and an enabler. They may also act as a barrier constraining industries and industrial processes from linking [4].

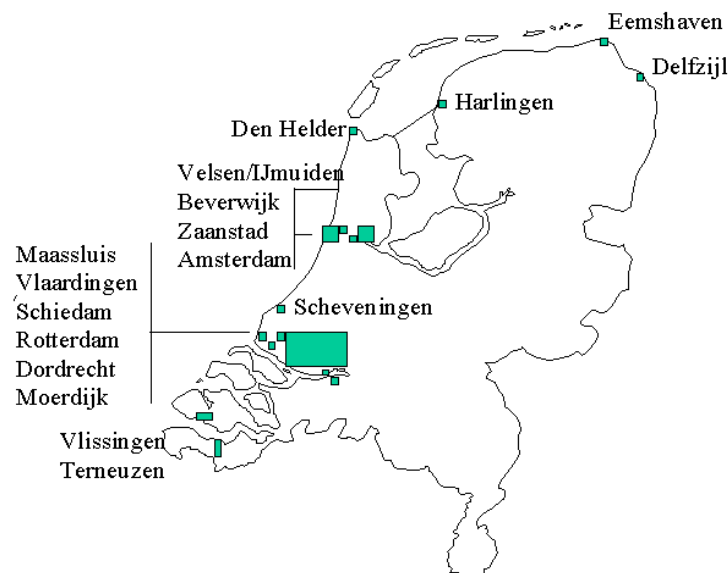
Proven technology (having the appropriate process and equipment available when required) and technical compatibility between industries in an area is also critical [8].

Overall there was general agreement that the right mix of factors needs to be present and balanced with no one factor too dominant [5,6]. Motivation will clearly be required.

Sakr et al [6] has also suggested that IE is seen as a ‘natural’ stage for industrial system development<sup>1</sup>. Has this been observed in the developing IE practices in the Netherlands?

### 3 Dutch Practice

Dutch ports are a vital part of the Dutch economy with half the country’s imports and exports transported via the ports [9]. In 2006 Dutch ports contributed €23.5bn direct added value and employed 274,000 people [11]. The National Ports Council (NPC), a tripartite council representing the port authorities (PAs), port users and the three levels of Dutch government (national, provincial and municipal), co-ordinates the Dutch seaports sector (see figure 1) [10].



**Figure 1:** Dutch ports and members of the National Ports Council (Havenraad) (NHR) *Source: NHR*

PAs are autonomous and may be independent, part of the municipality or private. The ports of Rotterdam and Amsterdam for example are independent. However the former’s majority shareholder is the city of Rotterdam and the port of Amsterdam is a separate part of the city of Amsterdam [10].

The PAs responsibilities include setting policy, and providing port facilities and the industrial land within their vicinities and its allocation [10,11]. They are supported by the spatial planning

<sup>1</sup> ... in “determining how” they “could be restructured” ..., or indeed constructed, ... to be “more compatible with the way natural eco-systems function”[30, page.531].

activities of the provincial and municipal authorities [11]. Master planning is an important tool used by both groups.

The National government is responsible for providing and funding the road, rail and inland waterway networks and for port entrances. In some cases infrastructure expansion is funded by the PAs [10]. The government actively supports the Port sector because of its important contribution, and the significant challenges it faces.

### **3.1        *The evolution of IE practices across Dutch Ports***

The practice of IE across Dutch port areas appears to have evolved from the Rotterdam area where there is a long history of association between industries dating back to 1958. This which continues today through Deltalinqs [8].

From the late 1980's industry was pressured by government to take pro-active responsibility for environmental management beyond 'mere' compliance [12]. In response a number of initiatives were launched by Deltalinqs and DCMR<sup>2</sup> [8] with university support.

A suggestion to test some of the lessons from Kalundborg gave rise to the INES project (Industrial EcoSystem) in 1994 to explore the potential for waste and emissions prevention and reduction through regional co-operation [4].

A number of potential opportunities for utility sharing and by product synergies were identified some of which progressed to implementation. Favourably received by government the project received funding and enjoyed a degree of flexibility from environmental constraints at the individual business level on condition that overall emissions were reduced [4,12].

The INES project evolved into further initiatives through the 1990s and 2000s as the sustainability agenda gained greater prominence.

As synergies such as the exploitation of surplus heat and CO<sub>2</sub> between neighbouring businesses have developed successfully they have become embedded as part of day to day business and planning principles; and best practice has been disseminated across the region and the country.

The National Government has been a supportive driver spurred on by the growing importance of the ports to the Dutch economy and the need to sustain growth challenged by space and environmental limitations and targets. The government has thus developed supporting policy and funding instruments. The facilitating role of the PAs and links to industry through business associations such as Deltalinqs, is also strongly supported [11].

The government's position is summarised in their 2008 'Policy Letter on Sustainable Seaports'<sup>3</sup> which encourages IE approaches in the actions required across at least two of the five policy themes ('Energy, CO<sub>2</sub> and Residual Flows' and 'Use of Space').

Multi-stakeholder platforms often supporting port area initiatives have played an important role sometimes formalised through covenants and targets. They have also helped inform the regional and national positions.

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<sup>2</sup> Dienst Centraal Milieubeheer Rijnmond

<sup>3</sup> Seaports as turntables towards sustainability



### 3.2 *Specific port developments*

A continuing driver for IE evolution across the **Rotterdam / Rijnmond** region is the Rotterdam Climate Initiative (RCI) established between the Port and City of Rotterdam, Deltalinqs and DCMR in 2007/8 [13]. The industrial ecosystem approach has been incorporated as a tool enabling collaborative improvements to be implemented with further developments planned [13].

Industrial ecology thinking was introduced at the **Port of Moerdijk** in the mid to late 1990s. The development of sustainable links is now a foundation of their business strategy.

**Zeeland Seaports** adopted an IE approach in 2006/2007. They are now actively marketing ‘Smart Links’ for competitive advantage.

A key strategy for the **Port of Amsterdam**, which hosts the iconic IS example: the Amsterdam Energy Company, is encouraging the pursuit of ‘Waste = Raw Materials in the Amsterdam Ports Region’.

The following sections will examine the development of synergies across these ports.

### 3.3 *Port of Rotterdam*

Over the decade, or more, of the INES projects many opportunities have proved unfeasible, but a number have been very influential and continue to evolve today.

#### *Utility sharing: steam*

A steam pipe network for sharing steam is being implemented in the Botlek area of Rotterdam after many years discussion. The partners include the Port of Rotterdam. Accessible by any business in the Botlek area, the system is anticipated to save 400,000 tonnes of CO<sub>2</sub> per annum and deliver air quality improvement (see table 2) [14,15].

#### *Links to horticultural businesses through OCAP*

Organic CO<sub>2</sub> for Assimilation of Plants (OCAP) is a JV supplying horticultural businesses with residual CO<sub>2</sub> from Shell Pernis. The synergy took a decade to bring to fruition, utilising a disused pipeline and a new 130 km distribution network of smaller pipes. [16,11] These connect 500 horticultural businesses covering an area of approximately 1300 hectares delivering 160 tonnes of CO<sub>2</sub>/hour [16].

The high quality CO<sub>2</sub> increases production and quality for the horticulturists at an attractive and stable price whilst saving 95 million m<sup>3</sup>/pa natural gas and 170,000 tonnes/pa CO<sub>2</sub> emissions (see table 2) [16].

**Table 2:** Examples of synergies in place at the Port of Rotterdam

Synergy name and parties	Resource flows and benefits	Drivers, Enablers, Barriers with DEB Framework Classification
<b>OCAP (Organic CO<sub>2</sub> for Assimilation of Plants)</b> <ul style="list-style-type: none"> <li>• Shell Pernis (petro-chemicals)</li> <li>• Linde Gas Benelux (JV partner) VolkerWessells (JV partner)</li> <li>• 500 horticultural companies (customers)</li> </ul>	<ul style="list-style-type: none"> <li>• 160,000 kg of CO<sub>2</sub> per hour delivered to pipeline network from Shell's hydrogen production.</li> <li>• Delivered to horticultural companies (covering 1300 hectares).</li> <li>• Horticulturalists save approx. 95 million cubic metres of natural gas pa.</li> <li>• CO<sub>2</sub> emissions reduced by about 170,000 tons pa</li> <li>• JV investment: 100 million euros in 130km network</li> </ul>	<u>Driver</u> <i>Economic: Cost of energy + Competitive advantage</i> <ul style="list-style-type: none"> <li>• Horticulturists achieve competitive advantage - better growing conditions &amp; reduced gas consumption.</li> </ul> <u>Enabler</u> <i>Economic: Business case</i> <i>Technical: Available infrastructure</i> <ul style="list-style-type: none"> <li>• Savings</li> <li>• Network deployment</li> </ul> <u>Barrier</u> <i>Economic: Supply stability</i> <ul style="list-style-type: none"> <li>• Continuity of supply if Shell production not maintained</li> </ul>
<b>Botlek Steam network</b> <u>Initiators:</u> <ul style="list-style-type: none"> <li>• Deltalinqs</li> <li>• Port of Rotterdam Authority, Stedin and Visser &amp; Smit Hanab</li> <li>• AVR, DSM and Cabot - two suppliers and one customer</li> </ul>	<ul style="list-style-type: none"> <li>• 400,000 tons of CO<sub>2</sub> per annum</li> <li>• Air quality improvement</li> <li>• Cost savings</li> </ul>	<u>Enabler</u> <i>Economic: Business case</i> <i>Regulatory: Environmental improvements &amp; incentives</i> <ul style="list-style-type: none"> <li>• Study showing economic feasibility for all participants (RCI, 2009)</li> <li>• CO<sub>2</sub> savings and better use of residual heat</li> </ul>

### 3.3.1 Latest developments at the Port of Rotterdam

Achieving the RCI's CO<sub>2</sub> emissions reductions of 50% by 2025 compared to 1990 will be challenging [13]. Radical solutions are required and a strategic partnership was signed between the Port of Rotterdam and GE in 2010 to share expertise and knowledge[17].

Maasvlakte II, the newest development area of the port, has been designed using IE principles and will be serviced through the provision of centralised utilities [18].

### Industrial ecology thinking now embedded

Resianne Dekker, Head of Environment at the Port of Rotterdam stressed that co-siting and clustering of businesses across the port estates is part of the standard leasing process. Sharing of residual materials, water and energy have been 'normal practice' for as long as she can remember. 'It simply makes good business sense!' If necessary the port can use its spatial planning instruments to steer things in the right direction; and will initiate or get involved in projects such as the 'Steam Network' [19].

### 3.4 Port of Moerdijk

The Port of Moerdijk is considered a leading light in the area of eco-industrial park development [8]. Moerdijk was established as a petro-chemical cluster in the 1970s linking Shell Moerdijk via pipelines to Shell Pernis (Rijnmond). Numerous material flows exist between Shell and related cluster organisations at Moerdijk such as Kolb, Montell and Basell. Businesses are represented by their association (BIM). The Port Authority acts as champion and facilitator.

## Development as eco-industrial estate

In 1995, the provincial government of North Brabant (Provincie Noord-Brabant: PNB) commissioned a study to review environmental practices across the port estate. This resulted in an action plan to redevelop the port and industrial area as an eco-industrial estate [8].

Progress is supported through a multi-party steering group, the Moerdijk Management and Co-ordination Group for Safety and Environment (SCMVM) providing funding and helping to remove any barriers [8, 20].

New zoning of the industrial estate was agreed and implemented in 1999 with seven areas<sup>4</sup>. These are carefully managed and new businesses ‘vetted’ for their fit before acceptance [8, 20].

## Current collaborations

Shell, the anchor tenant, supports a number of residual flows including the co-sited municipal incineration plant (AZN) and co-generation plant (Essent) who share flows of steam (see table 3).

Other beneficial relationships link NV Slibverwerking Noord-Brabant (SNB) and Omya Beheer BV (Omya). The CO<sub>2</sub> generated from SNB’s sewage sludge incineration is transported by pipeline to Omya where it is used in the production of calcium carbonate. Omya also receives CO<sub>2</sub> from Shell.

## Sustainable Links Moerdijk

The successes led to a detailed assessment to identify further linkages. These are outlined in ‘Sustainable Links Moerdijk’ (figure 2) supported by an enabling agreement and funding instruments signed by the SCMVM parties in April 2009 [21,22].



**Figure 2:** Sustainable Links at Moerdijk

Source: Moerdijk Port Authority

<sup>4</sup> Seaport, eco-park, industrial park, trade park (multi-modal distribution), distri-boulevard (road based distribution centres), service point (truck service, customs, meeting facilities etc.), and miscellaneous (connection corridors) [8,20].

**Table 3:** Examples of synergies in place at Moerdijk

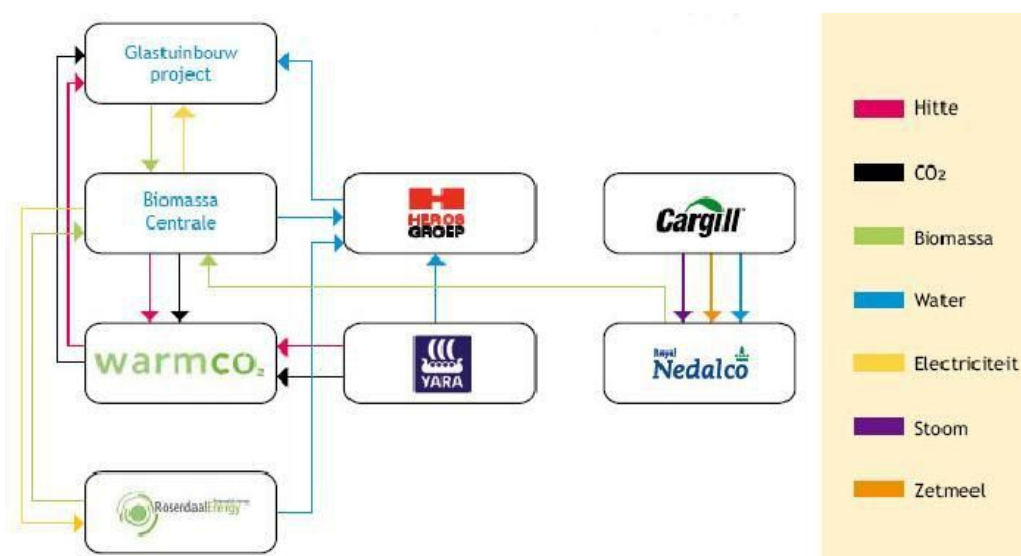
Synergy name and parties	Resource flows and benefits	Drivers, Enablers, Barriers with DEB Framework Classification
<ul style="list-style-type: none"> <li>Shell Moerdijk</li> <li>Omya Beheer BV (Omya) (calcium carbonate production)</li> </ul>	<ul style="list-style-type: none"> <li>CO<sub>2</sub> from Shell manufacturing processes sent to Omya for production of calcium carbonate</li> </ul>	<u>Enabler</u> Regulatory: <i>Environmental improvements</i> Technical: <i>Material compatibility</i>
<b>Shell/AZN/Essent</b> <ul style="list-style-type: none"> <li>Shell Moerdijk (chemical plant)</li> <li>AZN (municipal incineration plant - Afvalverbranding Zuid-Nederland)</li> <li>Essent (gas fired power station -Essent Warmtekrachtcentrale Moerdijk)</li> </ul> <p>Saves 60 million m3 gas pa</p>	<ul style="list-style-type: none"> <li>Exhaust gases from AZN go to boiler where water is converted to steam (400 deg). Steam passes to Essent replacing / supplementing natural gas use for electricity and heat generation.</li> <li>Passing through their boiler the steam reaches 525 degrees.</li> <li>200 tons of steam per hour is produced.</li> <li>Shell receives 150 tons of steam.</li> <li>The remainder is returned to water at Essent (closed loop).</li> </ul>	<u>Enabler</u> Technical: <i>Co-siting</i> <ul style="list-style-type: none"> <li>Co-location and design – Built at port from concept i.e. the synergies were part of the economic and environmental design</li> </ul>
<ul style="list-style-type: none"> <li>Shell Moerdijk</li> <li>Omya Beheer BV (Omya) (calcium carbonate production)</li> </ul>	<ul style="list-style-type: none"> <li>CO<sub>2</sub> from Shell manufacturing processes sent to Omya for production of calcium carbonate</li> </ul>	<u>Enabler</u> Regulatory: <i>Environmental improvements</i> Technical: <i>Material compatibility</i>
<ul style="list-style-type: none"> <li>NV Slibverwerking Noord-Brabant (SNB) (sewage sludge processing)</li> <li>Omya Beheer BV (Omya).</li> </ul>	<ul style="list-style-type: none"> <li>Incineration of sewage sludge (95k tpa) releasing CO<sub>2</sub>.</li> <li>CO<sub>2</sub> piped to Omya for calcium carbonate production.</li> <li>Calcium carbonate used as a whitener / pigment for the paper industry</li> <li>Investment costs approx 3m euros</li> </ul>	<u>Enabler</u> Regulatory: <i>Environmental improvements</i> Technical: <i>Material compatibility</i> Economic: <i>Business case</i>
Energyweb Appelweg <ul style="list-style-type: none"> <li>BEWA (AD plant)</li> <li>Bolsius (Candle manufacturer)</li> <li>DCS (Industrial paint &amp; coating)</li> </ul>	<ul style="list-style-type: none"> <li>Electricity generated by BEWA from by-products of AD sold to Bolsius and DCS for use in their processes via Appelweg link.</li> </ul>	<u>Driver</u> Economic: <i>Cost of energy</i> <u>Enabler</u> Economic: <i>Business case</i>

### 3.5 Zeeland Seaports

At Zeeland Seaports well established industries capitalised on their residual resource streams through symbiotic linkages. This success was recognised by Zeeland Seaports and other stakeholders. Valuepark Terneuzen (VPT) and Biopark Terneuzen (BPT)<sup>5</sup> resulted and were established in 2007. BPT aims to attract more agro-industrial businesses supported by smart links to interconnect resource streams (see figure 3). A multi-stakeholder partnership was also established including local and provincial government, academics and the PA as facilitator and champion [24,25].

Existing synergies include links between Cargill and Nedalco which have evolved over time, pipelines replacing road transportation. Cargill provides residual starch, steam, purified water, power and compressed air to Nedalco for bio-ethanol production. Nedalco feeds back water for re-processing (see table 4) [24].

WarmCO<sub>2</sub>, a JV between the PA, Yara and an infrastructure specialist is delivering heat and 70,000 tonnes per annum of pure CO<sub>2</sub> to newly established horticultural producers. Connected via a dedicated metered pipeline they now enjoy a stable supply of heat at an attractive tariff (see table 4) whilst Cargill and Yara receive an income stream for previously emitted CO<sub>2</sub> [24,25].



**Figure 3:** Biopark Terneuzen Smart links [25]

Note: hitte = heat, biomassa = biomass, electriciteit = electricity, stoom = steam, zetmeel = starch.

This has led to development of the Multi-User Provider (MUP) concept to provide organisational and physical infrastructure linking users in five clusters across the port area. The MUP will bring together ‘infra’ providers to manage the service corridors and new utility providers (contracted suppliers and purchasers of CO<sub>2</sub>, gas, heat, biodiesel, electricity and (hot) water. Realisation is being assisted through the Ports Adapting To CHange (PATCH) Interreg IV-A project [26].

This has also led to cross border co-operation with the Ghent Bio Energy Valley in Belgium to form Bio Base Europe. A pilot production plant and training centre is being developed to help develop skills for the bio-based sector [24,27].

<sup>5</sup> Partners include Cargill, Nedalco, Yara, EcoServices, ESV Groep, Heros Groep, Rosendaal Energy, Valuepark Terneuzen (JV Zeeland Seaports & Dow Benelux), Gemeente Terneuzen, Provincie Zeeland, Zeeland Seaports Port Authority [25].



Dick Engelhardt, Zeeland Seaport's Head of Infrastructure and Spatial Planning, stressed the need to move towards cost effectiveness and long term sustainability without the need for subsidy. Progress is supported by the preparedness of the businesses to invest in the future, and economic sense has also remained firmly in the foreground. It is now hoped that the model for a few square kilometres can be replicated over a larger area [24].

**Table 4:** Examples of synergies in place at Zeeland Seaports

Synergy name and parties	Resource flows and benefits	Drivers, Enablers, Barriers with DEB Framework Classification
<ul style="list-style-type: none"> <li>Cargill (food and agricultural products)</li> <li>Nedalco (bio-ethanol production)</li> </ul>	<p><u>Cargill to Nedalco:</u></p> <ul style="list-style-type: none"> <li>residual starch, steam, purified water, power, compressed air</li> </ul> <p><u>Nedalco to Cargill</u></p> <ul style="list-style-type: none"> <li>Water for reprocessing</li> </ul>	<p><u>Enablers</u></p> <p><i>Economic: business case</i></p> <p><i>Regulatory: Environmental improvements</i></p> <ul style="list-style-type: none"> <li>Reduced costs and environmental impacts</li> </ul>
<p>WarmCO<sub>2</sub> (JV) – Partners:</p> <ul style="list-style-type: none"> <li>Zeeland Seaports PA</li> <li>Yara Sluiskil (mineral fertiliser)</li> <li>Horticultural businesses in a 250 ha area - customers</li> </ul>	<ul style="list-style-type: none"> <li>Heat to WarmCO<sub>2</sub> (from cooling water from Yara's heat exchangers)</li> <li>CO<sub>2</sub> (70,000 tonnes pa) from Yara to WarmCO<sub>2</sub></li> <li>From WarmCO<sub>2</sub> to customers</li> </ul> <p><u>Savings</u></p> <ul style="list-style-type: none"> <li>CO<sub>2</sub> emissions avoidance equivalent to twice natural gas required for town of 55,000 people.</li> </ul> <p><u>Investment:</u></p> <ul style="list-style-type: none"> <li>Dedicated metered and specially engineered pipelines</li> </ul>	<p><u>Drivers</u></p> <p><i>Economic: Cost of energy and Competitive advantage</i></p> <p><i>Regulatory: Incentives</i></p> <ul style="list-style-type: none"> <li>Beneficial use of residual CO<sub>2</sub> for producers</li> <li>Competitive advantage for growers from enhanced environment</li> <li>Reduced costs relating to emissions</li> <li>Fixed price for energy and CO<sub>2</sub> for 15 years</li> <li>No longer subject to fluctuations in energy prices</li> </ul> <p><u>Enablers</u></p> <p><i>Economic: Business case and Stable supply</i></p> <ul style="list-style-type: none"> <li>Attractive supply for customers</li> <li>Reduced costs in gas usage</li> <li>Sustainable supplies and customer base</li> </ul>

### 3.6 Port of Amsterdam

A number of initiatives at the Port of Amsterdam (PoA) have evolved through its close links with the City government.

#### The Amsterdam Energy Company

The Amsterdam Energy Company AEB (Afval Energie Bedrijf) is located at the Port and operated by the City of Amsterdam. It is a showcase for Dutch waste management practice [31].

Two incinerators are co-located with a waste water treatment plant. Feedstock includes municipal and commercial waste, and sewage sludge from the water treatment plant. 1 million MWh electricity per annum supplies the City powering its tram and metro systems, street lighting and several buildings [11,31] (table 5).

Westport Warmte (WPW), a joint venture between the City and Nuon (an energy company) takes heat from AEB and supplies local businesses and residents [32].

Continuous research and process improvement has led to minimal residual waste as a wide range of by-products have been developed [31].

### **Greenmills**

Greenmills is also significant. A partnership between organisations producing bio-diesel, bio-ethanol and biogas its feedstock includes residual streams from port area food and animal feed producers. Co-operation and co-location enables the businesses to gain logistical advantages and use residual resources such as heat and water more efficiently [32] (table 5). One of the businesses is also connecting to WPW, extending the reach of the district heating system. The link has been supported by PoA's sustainability and innovation fund [32,33].

### **Sustainable Port and City**

The City and PoA are investing in sustainability for the community and as an important differentiator for inward investment and have jointly set targets to reduce CO<sub>2</sub> emissions by 40% by 2025 [34].

Additionally a project 'Waste = Raw Materials in the Amsterdam harbours region' initiated by the City and PoA has surveyed port area businesses to identify potential synergies from residual resources. There has been some success including identification of phosphorous rich material from Greenmills which is now being utilised by ICI Fertilisers Europe [32,33].

## **3.7 Discussion**

These examples demonstrate the development of IE practices across Dutch port estates.

Initial drivers appeared to be government pressure for environmental responsibility extending beyond 'end of pipe' compliance. Environmental drivers remain strong today. Drastic reductions in greenhouse gas emissions and air and noise quality improvements necessitates a re-think in 'how to do business' and can drive down costs. The development of a 'Sustainable Port' is also seen as an important competitive differentiator to attract desirable tenants.

Dutch ports have built upon some important enablers. Their positions as landlords and the prevalence of industry associations have supported champions and cohesion. Businesses have been willing to get involved. Shared intent and endeavour has been delivered through multi-stakeholder engagement. Knowledge institutes have helped deliver technical expertise and innovation. Exchange of information and best practice has been important. Co-siting and clustering can support exchanges and utility sharing. All of these factors have combined to provide positive momentum to embed IE thinking into the way of 'doing business around here'.

Two important barriers appear to be scale factors e.g. having a small enough scale for a manageable pilot or a large enough scale for economic viability. The stability of supply is also important.

It seems clear that the practices have delivered real benefits such as in the exchange of residual CO<sub>2</sub> flows between industry and the horticultural businesses and utility sharing.

The framework was also found to be robust. All the drivers and enablers were present, although there was less evidence of barriers.

**Table 5:** Examples of synergies in place at Port of Amsterdam

Synergy name and parties	Resource flows and benefits	Drivers, Enablers, Barriers with DEB Framework Classification
<p><b>Amsterdam Energy Company</b></p> <p><u>Suppliers:</u></p> <ul style="list-style-type: none"> <li>Waste contractors and City of Amsterdam</li> <li>Sewage treatment Plant</li> </ul> <p><u>Customer:</u></p> <ul style="list-style-type: none"> <li>Westport Warmte (WPW)</li> </ul>	<ul style="list-style-type: none"> <li>Waste flows (4400 tonnes per day) and sewage sludges incinerated</li> <li>Excess heat captured. Some used for electricity generation</li> </ul> <p><u>Residual streams:</u></p> <ul style="list-style-type: none"> <li>1 million MWh of <b>electricity</b> and <b>heat</b> supplied to WPW for City of Amsterdam</li> <li>Flue gas recovery including: <ul style="list-style-type: none"> <li>Sulphur to gypsum board</li> <li>Calcium chloride for road 'salt'</li> <li>Mineral residues to asphalt production</li> </ul> </li> <li>Bottom ash recovery: <ul style="list-style-type: none"> <li>Pilot plant for precious metal recovery</li> <li>Granulate and artificial sand for building</li> <li>Development for concrete &amp; asphalt raw materials</li> </ul> </li> </ul>	<p><u>Drivers</u></p> <p><i>Regulatory: Incentives and taxes</i></p> <ul style="list-style-type: none"> <li>Landfill avoidance</li> </ul> <p><u>Enablers</u></p> <p><i>Economic: Business case</i></p> <ul style="list-style-type: none"> <li>Revenue from supply of heat and electricity and other residual streams</li> </ul>
<p><b>GreenMills</b></p> <p><u>Partners:</u></p> <ul style="list-style-type: none"> <li>Noba Vetverdeling (bio-diesel)</li> <li>Rotie BV (bio-diesel from recycled oils and fats)</li> <li>Orgaworld (electricity and heat from biogas)</li> </ul> <p><u>Suppliers</u></p> <ul style="list-style-type: none"> <li>Food (incl. animal feed) producers across port estate and elsewhere</li> </ul> <p><u>Customers</u></p> <ul style="list-style-type: none"> <li>Include WPW for electricity and heat</li> </ul>	<ul style="list-style-type: none"> <li>Residual organic materials from suppliers – 100,000 tonnes</li> <li>Bio-diesel (100,000 tonnes)</li> <li>Biogas (25 m m<sup>3</sup>)</li> <li>Heat and electricity to WPW</li> </ul>	<p><u>Drivers</u></p> <p><i>Economic: Cost reduction</i></p> <ul style="list-style-type: none"> <li>Shared costs and facilities for partners</li> </ul> <p><u>Enablers</u></p> <p><i>Technical: Co-siting</i></p> <ul style="list-style-type: none"> <li>Shared infrastructure [designed in]</li> </ul>



## **4 Comparative analysis between UK and Dutch ports**

### **4.1 *UK port industry***

The structure of the UK port industry is very different to the Netherlands. The ports are vital to the economy supporting 95% of imports and exports, yet the UK government takes a rather passive position providing negligible support. The ports, including their connecting rail infrastructure, are considered as strictly private sector assets.

Other key differentiators include limited historical industrial development within the port estate itself. Causal factors include the National Docks Labour Scheme (NDLS) which limited port war growth and privatisation programmes which led to port land disposal [23].

These and other factors are highlighted below in the comparative analysis.

### **4.2 *Comparative analysis***

#### **Economic Contribution**

Both Dutch and UK ports are critically important for their respective economies and attract an agglomeration of diverse businesses. Anchor tenants and industries who can be key influencers for IE are less prevalent in UK port areas.

#### **The port and its vicinity**

In the Netherlands the port is likely to be considered as the whole port area including its industrial complexes. In the UK the port is generally considered as the area supporting port operations.

This distinction is important when considering, for example, the impact and influence of the port on the area's sustainability: its economy, environment and social aspects, and the way it is treated in policy terms.

#### **Representation and Policy**

Whilst both Dutch and UK ports are governed by their Ministries of Transport the UK does not have a multi-stakeholder National Ports Council supporting and informing the government. The UK representative bodies (British Ports Association and UK Major Ports Group) are trade associations focused on port operations.

UK port policy is therefore slanted towards the port itself rather than its holistic connectivity to the local, regional and national economic systems, exacerbated by UK government's insistence on private port financing even for links to the transport network. Considered as a national asset in the Netherlands, this may limit opportunities for modal shift.

In the Netherlands ports strong links with their municipality, their landholdings and environmental challenges strengthen their sense of stewardship and responsibility for the sustainability of their tenants and their own operations. This sense of shared responsibility and shared targets for improvement provide a legitimised foundation for co-operative action. This is not evident or generally felt in the UK. The port is more likely to be run with an internal focus on the port's operations for the benefit of its owners.

## **Environmental Drivers**

Environmental regulations and legislation continue to be strong drivers towards collaborative solutions in the Netherlands but these influences are far weaker in the UK. Whilst low carbon drivers do present opportunities the multi-stakeholder co-operation often needed to deliver solutions are rare.

Dutch government policy explicitly encourages re-use of residual resources and by-products where these cannot be engineered out, and the port agglomerations support this. Expertise and multi-party collaboration has also developed to break down barriers and improve awareness and viability. This growing expertise across port areas has become a competitive differentiator, growth generator and part of day to day business behaviour. Such behaviour appears limited in UK to isolated pockets e.g. Humberside and Bristol where organisations such as NISP have brought expertise and awareness. It is far from systematic.

## **Business relationships**

Dutch ports have strong links to their businesses through the association of local businesses and role as landlord. Such associations are uncommon in the UK.

In the Netherlands master planning is also an important tool for PAs, regional and local government and stakeholders to agree a shared vision, targets and strategies for their achievement. Its take up remains limited in the UK despite strong advocacy from the Department for Transport. However the ports of Newhaven and Shoreham have found the process beneficial [28, 29].

## **Conclusions**

Not all the same conditions are present in the Dutch and UK port sectors highlighted by the framework tool for IE drivers, enablers and barriers. Enablers, particularly motivational and informational, are limited with a higher incidence of barriers.

Key differences relate to structure and scale. A UK port is not generally viewed as a holistic agglomeration or have the strong bonds and shared vision with the local municipality evident in the Netherlands. Similarities include the same European environmental drivers and necessity to de-carbonise and improve resource efficiency.

The empirical research into SW port operations is now explored further.

## **5 Potential for IE across ports in SW England**

The potential for IE across ports in SW England was informed by literature reviews, the SW Ports Study and by the BPE&VI demonstration project conducted in parallel.

### **5.1 SW Ports Study**

A group of twenty port businesses (see table 6) participated in the detailed study of South West ports. Predominantly commercial ports they provide a cross section of port type, size and activities around key estuaries. The objective was to better understand governance structures, interactions and relationships with local and regional economies and the maturity of their sustainable resource management.

A detailed questionnaire was developed to support a semi-structured interview process undertaken between November 2008 and February 2009.

## 5.2 *The Bristol Port Estate and Vicinity Initiative (BPE&VI)*

The BPE&VI is a demonstration project across The Bristol Port Company's (BPC) estate and vicinity encouraging sustainable resource management between participating businesses. Kicked off by a pilot group of businesses, an initial NISP 'Quick Wins' workshop in September 2009 was attended by 40 organisations. Its success led to establishing quarterly events and other enablers including a shared workspace. Over 90 organisations have attended events and actively support the initiative. Benefits include cost savings of £287,500 up to June 2011.

**Table 6:** Participating Ports

<p><b>Fal Estuary:</b> A&amp;P Falmouth Falmouth Harbour Commissioners The Ports of Truro and Penryn Porthoustock Quay</p> <p><b>Fowey</b> Harbour Commissioners</p> <p><b>Plymouth and Tamar Estuary</b> Queens Harbourmaster - HMNB Devonport Sutton Harbour ABP Millbay Cattewater Harbour Commissioners Babcock Marine at Devonport Bardon Aggregates at Pomphlett Wharf Cattedown Wharves Coastal Officer responsible for TECF (Tamar Estuaries Consultative Forum)</p>	<p>Port of <b>Exeter</b></p> <p><b>Teignmouth:</b> ABP Teignmouth Teignmouth Harbour Commissioners</p> <p><b>Weymouth &amp; Portland</b> Weymouth Harbour Portland Port Company</p> <p><b>Poole</b> Harbour Commissioners</p> <p><b>Severn Estuary:</b> Port of Bridgwater The Bristol Port Company</p>
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## 5.3 *Findings*

In the SW there is little heavy industry. This may limit the **availability of** certain **resources for re-use**. Traditional **anchor tenants** (generally petro-chemical industry and utilities) are uncommon. However experiences from BPE&VI have shown that **businesses**, such as Lafarge Plasterboard, D S Smith Packaging and ADM Milling, do feel **committed** to supporting an initiative which connects them to the area and can provide benefits.

Unlike the Netherlands, **landholdings** are generally limited to an area close to the port's operations. The Bristol Port Company has the largest **estate** in the SW. The BPE&VI has demonstrated that the vicinity around the port can be considered as an extended 'virtual estate' providing a community of interest for resource efficiency. The port operation itself may not feel driven to facilitate co-operation unless there is 'something in it for them'.

The Study highlighted the growing importance of **environmental management and formal systems** although dedicated environmental resources are uncommon, limiting activities outside the core business. Transparency of information in the public domain was generally low (with a

few exceptions) suggesting a reluctance to exchange information and adversely impacting perception of the port operation by its stakeholders.

**Relationships with businesses on the estate or in the area**, were limited, generally focused on health, safety and security. The port operations felt they had little opportunity to influence local business or the local economy nor felt they were part of a 'greater port area' as a member of which they could be an influencer. The absence of a business association may also be a factor. This contributes to the fragmentation and isolation of the port operation from the business and general community with some notable exceptions (Fowey consortium and BPE&VI).

**Multi-stakeholder groups** are a rarity in the South West although estuary management groups are an example.

There are opportunities for improving the **efficiency and effectiveness of energy and water** usage and introducing **carbon management**.

**Management of waste** was generally focused on provision of adequate facilities rather than on waste minimisation and recycling/re-use. There were opportunities for economically viable re-use of residual resources such as fish meat and shells, sweepings and spillages, international catering waste and dredged materials.

In the Netherlands **pressing environmental factors** necessitate operational 'engineering' to manage impacts within the confines of current and future legislation. These were not raised as factors within the Study Group. Drivers for action included reducing the cost of energy, water and waste disposal and dealing with the impacts of the Carbon Reduction Commitment energy efficiency scheme where relevant.

There was no indication from the Study Group of **shared municipal targets** for carbon reduction and resource efficiency, evident in the Netherlands.

There was also little evidence of a holistic approach to **port area planning**, nor an understanding of the future implications of sustainable development except for the Sustainable Development strategy of Carrick Maritime Board (Truro and Penryn).

The Study highlighted specific port operations where **development opportunities** and/or **estate wide initiatives** have potential e.g. Devonport, Poole, Bristol, Falmouth and Portland. Stakeholder dialogue is encouraged to move them forward and/or enhance their potential.

The study has indicated that opportunities for IS initiatives such as smart linking steam, CO<sub>2</sub> etc. may be limited although a thermal heat grid feasibility study is underway in Bristol.

Opportunities in the area of **offshore renewables** are also looking particularly interesting. Government support and financing remain a stumbling block despite the potential for port areas to contribute to the nation's sustainable development.

## **6 Discussion, Conclusions and Recommendations**

### **6.1 *Why has IE not been more widely adopted in the UK?***

The evolution of IE practice across Dutch port areas continues to be stimulated by the need to find innovative solutions to address growing environmental challenges and drive down costs. Solution finding has been supported through government policy and instruments. The shared visions and targets for carbon reduction set by Dutch municipalities, of which ports are generally a part, are also supportive together with the enabling multi-stakeholder community of interest.

The drivers are far weaker in the UK. More private ownership, smaller land holdings, hands off government policy and absence of business associations has failed to create an environment where IE practice can flourish. A concerted effort from an outside party is necessary together with a compelling business case.

### **6.2 *How could it be enabled?***

Organisations have a strong desire to reduce resource costs. Wide spread dissemination of IE case studies and more enabling policy would be helpful.

### **6.3 *Opportunities for beneficial application of IE in SW England?***

The empirical research has highlighted areas where opportunities exist and could be explored, including alternative uses for residual resources. The Fowey consortium is demonstrating how stakeholder collaboration can generate business opportunities from developing new uses and markets for residual materials.

Other areas include recovery of heat from waste materials (e.g. biomass plants) and estate wide co-operation across port operations and their tenants which might include shared waste facilities.

### **6.4 *How this might be developed.***

In the absence of strong local environmental drivers and established social engagement mechanisms between businesses, building interest in working together is essential. An approach is to engage a pilot group of businesses to develop initial successes and ripple out through engagement mechanisms such as a NISP Quick Wins workshop. Sustaining interest needs a commitment to leadership, facilitation, technical expertise and resources for information exchange.

### **6.5 *Other Findings***

The study also highlighted the benefits to be gained from other resource management tools such as an environmental management system.

### **6.6 *Recommendations***

PAs should get to know their tenants and other local businesses better enabling mutual opportunities to be identified. Collaborative working with stakeholders is also recommended.

The research has identified a number of areas where policy is weak or can have detrimental impacts. For example waste and resource management legislation should more actively encourage collective approaches and the means to support these.

The findings should be widely disseminated across the SW England port industry, and further developed during 2012. Opportunities should be explored with SWRPA to promote regional co-operation. Port area initiatives should be developed e.g. in Falmouth and Plymouth where potential for improved resource efficiency through IE has been identified. Embedding IE thinking into area wide planning has value and research should be undertaken to examine its application to support port master planning.

## **6.7            *To conclude***

This body of research has delivered both academic and practical contributions to the field of IE and its application across port areas. An understanding of the drivers, enablers and barriers has been developed into a transferable framework.

On a practical level, the research provides evidence that the application of IE across port areas does have potential to leverage commercial advantage and support sustainable development in SW England. More research is needed to better evaluate the extent of this potential. However, the evidence also highlights the value of other tools and approaches such as resource management systems in helping achieve these aims.

Complementary policy drivers and instruments, used beneficially in The Netherlands, are also an essential ingredient in the UK together with the need for co-operative engagement between the businesses, government and their stakeholders. It is hoped that this work has built a foundation which can, at least, start to enable stakeholder dialogue for IE to achieve its potential and contribute to sustainable development in the UK.

## References

- [1] **Clift, R., 2001.** Clean Technology and Industrial Ecology pp 411-444 in Harrison R.M(ed) *Pollution Causes, Effects and Control* (The Royal Society of Chemistry, Cambridge).
- [2] **Garner, A. and Keoleian G.A, 1995.** Industrial Ecology: An Introduction. National Pollution Prevention Center for Higher Education • University of Michigan.
- [3] **Chertow, M., 2004.** Industrial Symbiosis. *Encyclopaedia of Energy*,3 pp.407-415.
- [4] **Brand, E. and de Bruijn,T., 1999.** Shared Responsibility at The Regional Level. *European Environment*,9 p.221-231 (1999).
- [5] **Mirata, M. 2004.** Experiences from the early stages of a national industrial symbiosis programme in the UK: determinants and co-ordination challenges. *Journal of Cleaner Production*,12[2004] p.967-983.
- [6] **Sakr, D., et al., 2011.** Critical success and limiting factors for eco-industrial parks: global trends and Egyptian context. *Journal of Cleaner Production*, In Press, Corrected Proof, Available online 18 January 2011.
- [7] **Kincaid, J. and Overcash, M. , 2001.** Industrial Ecosystem Development at the Metropolitan Level. *Journal of Industrial Ecology*,5[1] p.117-126.
- [8] **van Berkel, R., 2006.** Regional Resource Synergies for Sustainable Development in Heavy Industrial Areas: An Overview of Opportunities and Experiences. [online]. Available at: <http://www.c4cs.curtin.edu.au> [Accessed date: 28th May 2009].
- [9] **Ministerie van Verkeer en Waterstaat (MvVW). 2011.** Seaports and Ocean shipping. [online]. Available at: [http://english.verkeerenwaterstaat.nl/english/topics/freight\\_transportation/seaports\\_and\\_ocean\\_shipping/index.aspx](http://english.verkeerenwaterstaat.nl/english/topics/freight_transportation/seaports_and_ocean_shipping/index.aspx) [Accessed date: 27th April 2011].
- [10] **Nationale Havenraad (NHR). 2011.** National Ports Council in the Netherlands . [online]. Available at: <http://www.havenraad.nl/english/> [Accessed date: 27th April 2011]
- [11] **Ministerie van Verkeer en Waterstaat (MvVW). 2008.** Seaports as turntables towards sustainability: Policy letter on sustainable seaports. [online]. Available at: [http://www.verkeerenwaterstaat.nl/english/Images/Beleidsbrief\\_Engels%20DEF%20202\\_tcm249-242796.pdf](http://www.verkeerenwaterstaat.nl/english/Images/Beleidsbrief_Engels%20DEF%20202_tcm249-242796.pdf) [Accessed date: 9th June 2009].
- [12] **Boons, F., 2008.** Self-Organisation & Sustainability: The emergence of a Regional Industrial Ecology. *Self-Organisation and Sustainability*, E:CO 10[2 2008] p.40-47.
- [13] **Rotterdam Climate Initiative (RCI). 2011.** Over ons > Rotterdam Climate Initiative . [online]. Available at: [http://www.rotterdamclimateinitiative.nl/nl/50\\_minder\\_co2/over\\_ons/rotterdam\\_climate\\_initiative](http://www.rotterdamclimateinitiative.nl/nl/50_minder_co2/over_ons/rotterdam_climate_initiative) [Accessed date: 14th April 2011].
- [14] **Rotterdam Climate Initiative (RCI). 2009.** Steam pipe. [online]. Available at: <http://www.rotterdamclimateinitiative.nl/documents/samenvatting%20Op%20Stoom%20EN.pdf> [Accessed date: 16th April 2011].
- [15] **Port of Rotterdam (POR). 2009.** Port wants steam pipe for CO2 reduction . [online]. Available at: [http://www.portofrotterdam.com/en/News/pressreleases-news/Pages/20091126\\_01.aspx](http://www.portofrotterdam.com/en/News/pressreleases-news/Pages/20091126_01.aspx) [Accessed date: 16th April 2011].
- [16] **OCAP. 2011.** OCAP. CO2 voor de tuinbouw. [online]. Available at: [http://ocap.media-factory.nl/files/Media/Projectbeschrijving%20OCAP/Factsheet\\_UK.pdf](http://ocap.media-factory.nl/files/Media/Projectbeschrijving%20OCAP/Factsheet_UK.pdf) [Accessed date: 2nd August 2011].
- [17] **de Mattos, R.Teixeira and Schoenmakers, V., 2011.** GE & POR's Innovation Group. : GreenPort Conference, Venice, February 2011.
- [18] **Gemeente Rotterdam. 2004.** Port Vision 2020 Quality Chart. [online]. Available at: <http://www.havenplan2020.nl/html/uk/quality.html> [Accessed date: 1st August 2008].
- [19] **Dekker, R., 2009.** Personal communication: Email exchange between Resianne Dekker and Kate Royston, 09/09/09.
- [20] **Haven van Moerdijk (HvM). 2011.** Port of Moerdijk. [online]. Available at: [http://www.havenvanmoerdijk.nl/en/top\\_home.htm](http://www.havenvanmoerdijk.nl/en/top_home.htm) [Accessed date: 29th June 2011].



- [21] **SCMVM, 2009.** Proeftuin Schoon Bedrijfterrein-Haven-en industrisierrein Moerdijk: Intentieovereenkomst "Duurzame Verbindingen Moerdijk" 2 April 2009. : Memorandum of Understanding.
- [22] **Rentrop, J., 2009.** Personal communication: Meeting between Jacco Rentrop (Environmental Manager, Port of Moerdijk) and Kate Royston, 26/08/09.
- [23] **Rentrop, J., 2011.** Personal communication: Conversation between Jacco Rentrop (Environmental Manager, Port of Moerdijk) and Kate Royston, September 2011.
- [24] **Engelhardt, D., 2009.** Sustainability in the bio/agro industry: A Case Study. : Zeeland Seaports.
- [25] **Biopark Terneuzen. 2011.** Biopark Terneuzen. [online]. Available at: <http://www.bioparkterneuzen.com/cms/publish/content/showpage.asp?pageid=995> [Accessed date: 29th June 2011].
- [26] **Zeeland Seaports. 2011.** Hidden Connections. [online]. Available at: <http://www.zeelandseaports.nl/en/projects/project:hidden-connections.htm> [Accessed date: 19th September 2011].
- [27] **Bio Base Europe. 2011.** Bio Base Europe. [online]. Available at: <http://www.biobaseeurope.eu/> [Accessed date: 29th June 2011].
- [28] **Marks, Richard, 2010.** Engaging the community in future plans. Presentation at the British Ports Association conference in October, 2010.
- [29] **Bennett, Richard, 2010.** UK Port Policy: The Year Ahead. Presentation from the Department for Transport at the British Ports Association conference in October, 2010.
- [30] **Erkman, S, 2001.** Industrial ecology: a new perspective on the future of the industrial system. Swiss Medical Weekly, 2001[131] p.531-538.
- [31] **AEB. 2011.** Welcome to Amsterdam's Waste and Energy Company . [online]. Available at: <http://www.aebamsterdam.com/en/home> [Accessed date: 22nd May 2011].
- [32] **Haven Amsterdam. 2011.** Port of Amsterdam. [online]. Available at: <http://www.portofamsterdam.nl/smartsite.dws?id=18493> [Accessed date: 11th April 2011].
- [33] **Veldman, H., 2011.** Personal communication: Conversation between Harmen Veldman (Strategy and Research, Port of Amsterdam) and Kate Royston, 31<sup>st</sup> August 2011.
- [34] **Justmeans. 2010.** Amsterdam- Sustainable City in the Making. [online]. Available at: <http://www.justmeans.com/Amsterdam-Sustainable-City-in-Making/15937.html> [Accessed date: 16th April 2011].



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**UK's Waste Policy Framework for ISD: Lessons for China?**

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**Abstract:**

This research analyses how China can draw on the UK's policy framework for ISD to improve its equivalent context lacking of mechanism promoting ISD among small and medium businesses (SMEs). The Chinese model focuses on “carrots” (e.g. government's funding support, preferential tax and guidance) to encourage and reward the adoption of innovative techniques in enterprises, industrial parks and cities for resource efficiency and pollutants reduction; whilst, the UK's model provides both “sticks” (e.g. landfill tax) and “carrots” (e.g. business facilitation programme and guidance) to facilitate businesses to engage with resource efficiency and landfill diversion activities.

The inspired points drawn upon the UK performance-based devolution model for ISD can be giving pressure to business to divert landfill; using “the tonnages of waste diverted from landfill” rather than the “pollutants reduction rate” as an important environmental protection assessment indicator; clarifying the responsibility boundary of the key government departments' role in promoting resource re-utilisation and pollutants reduction; opening up the resource efficiency data collection and calculation methods rather than only publishing the statistical data. Potential barriers and options to further incorporate the UK's experiences into the Chinese policy framework are given. The lesson drawing approach is an utilisation of the policy transfer (PT) theoretical points which provide guidance on factors to be considered in the process of PT.

**1. Introduction**

Over the last two decades, there has been substantial research on industrial symbiosis development (ISD) which is characterised by promoting business collaborations on the re-

utilisation of by-products, energy and other waste resources as a means of industrial sustainable development (Chertow, 2000). Worldwide there has been a process of diffusing, exchanging and applying ISD experiences. For example, in the USA, the early initiatives to establish IS networks from scratch within a park boundary (eco-industrial parks) were argued to be an attempt to replicate the patterns of Kalundborg IS networks (Chertow, 2000; 2008). With sources of public and private funding, a number of pilot eco-industrial parks (EIPs) were built at different US regions in the early 1990s aiming to promote regional sustainable development (Chertow, 2000; Deutz & Gibbs, 2004). However, empirical research findings show that these early attempts to apply the Kalundborg practice are problematic. For example, since the 1990s a number of the US EIPs have been confronted with a number of barriers including difficulties in recruiting tenants due to restricted recruiting policies and local lagging economic backgrounds (Gibbs & Deutz, 2005). Another example is the extensive academic work drawing on the experiences of networking facilitation approach for ISD represented by the UK's National Industrial Symbiosis Programme (NISP) (Mirata, 2004; Kim & Powell, 2008; Paquin & Howard-Grenville, 2009). Recently, the diffusion of the UK's ISD approach to other countries such as Romania and China, has received financial support from a number of national and international bodies (Laybourn & Morrissey, 2009) but the collaborative programmes are in an early stage with unclear domestic funding to develop the regional pilot programmes to a broader area in future.

The above cases suggest a fruitful avenue for study that is to explore how good practice on ISD in one country can be transferred to other countries for international ISD. However, according to findings from the policy transfer (PT) literature, dissemination of one region's good practice to another, even where it is well resourced and pursued actively can lead to disappointing results as the potential of utilising policy elements from elsewhere is affected by the context in which the PT process takes place (Bulmer & Padgett, 2004; Swainson & Loe, 2011). In this respect, there is a need to fully understand the context of the location where the good practice has been originally developed (Dolowitz and Marsh, 2000; Wolman and Page, 2002; Swainson & Loe, 2011). Within the IS literature, there is an awareness of the importance of policy frameworks that affect the national ISD. For example, the Danish government was seen to use environmental regulations emphasising performance standards rather than technology criteria to allow businesses to select pollution control technologies ensuring their waste streams can be utilised as other's feedstock (Gereffi, 1995). In addition, Danish ISD are seen to be promoted by its increasing incineration and landfill tax coupled with a strong landfill ban on combustible waste since 1997 (Costa *et al.*, 2010).

However, there has not been a substantial study on how the policy framework in one country for ISD can be drawn upon and utilised by others.

This research therefore uses ISD related policy contexts in the UK and China as case studies and discusses how China can learn from the UK's policy framework for ISD. The paper is structured as follows: section 2 establishes the theoretical framework to analyse the potential of PT from the UK to China; section 3 analyses the Chinese policy context targeting its resource, energy and environmental targets from the perspective of the adopted policy instruments and the delivery landscape from national to regional levels. Problems of the policy context are then discussed; section 4 describes the UK's performance-based devolution model for ISD; section 5 discusses how China can learn from the UK's model with the implementation of the PT theoretical points. The potential contextual barriers affecting the process of policy utilising in China will also be analysed.

## **2. Theory on policy transfer**

Due to increased networking between policy-makers and politicians and the globalisation of advisory and consultancy businesses, governments have gained more chances to learn from the experience of other governments (Dolowitz *et al.*, 2000; Marsden & Stead, 2011). Learning from other geographical contexts is seen as a means to address continuing policy failures that do not respond to indigenous policy innovations (2005). Meanwhile, nations applying for international grants, loans or membership are often required by the international bodies to adopt specific laws and policies as a condition of transactions being undertaken (Luo, Catney, & Lerner, 2009). With this growing prevalence of PT practices, studies of PT theory has increased over the past two decades.

Definitions of PT vary between commentators but the core idea is that it involves a process of taking knowledge about policy-making from one jurisdiction and applying it to another (Marsden & Stead, 2011). One of the most frequently cited definitions of PT is that it is 'a process in which knowledge about policies, administrative arrangements, institutions, *etc.* in one time and/or place is used in the development of policies, administrative arrangements and institutions in another time and/or place' (Dolowitz & Marsh, 1996, p. 344).

The theoretical framework of PT has viewed the transfer as a process covering knowledge assessment and utilisation based on communications amongst the participants (Wolman & Page, 2002). In the assessment stage, the recipient should evaluate the quality and relevance of the received information. Also, the contextual factors (e.g. political, cultural, historical elements) for where the knowledge is currently in place should be understood (Dolowitz and Marsh, 2000; Swainson & Loe, 2011). In the utilisation stage, the learned experience can just be taken into account in the policy-decision process without an adoption (Wolman & Page, 2002). Regarding the extent to which the learned policy can be adopted, Rose (1993; 2005) categorises a number of policy utilising forms: (1) the direct copying of a programme without adaption; (2) emulation - adoption with adaptation to certain contextual factors; (3)

hybridisation or synthesis - the elements of the transferred programmes are combined; (4) inspiration – experiences elsewhere stimulate new ideas about how programmes could be reshaped, without necessarily utilising any parts of cases examined. These four forms of utilisation are treated as the different degrees of PT (Dolowitz et al., 2000). Through analysing the relationship between the degrees of PT and specific transfer processes, researchers argue that empirically, the direct copying or emulation appears to be caused by ‘hard’ coercive transfer, such as PT under conditions of Europeanisation (Bulmer *et al.*, 2007); whilst, the lower degree of PT is argued to be resulted from ‘softer’ forms of transfer, such as PT under the globalisation or internationalisation (Benson & Jordan, 2011).

Rather than studying the process of PT of a specific case, this research is an application of the above PT theoretical points to analyse how China can draw on the UK’s ISD policy framework for targeting resource, energy and environmental goals. Potential contextual factors affecting the utilisation of the UK’s experiences on ISD are considered.

### **3. The Chinese policy context targeting resource efficiency and pollutants reduction: status and problems**

The Chinese policy context for ISD is shaped by national policies targeting resource efficiency and pollutants reduction. To achieve these targets, the government has promoted development models such as resource comprehensive re-utilisation (RCR) and the Circular Economy (CE). With regard to the RCR concept, resource refers to mineral by-products, waste residues (water or gases), and various waste or outdated products. Comprehensive re-utilisation means recycling, regenerating and reusing activities (The former State Economic and Trade Commission, 1996). The broader concept, CE development mainly refers to the promotion of resource conservation, cleaner production, RCR, and environmental protection industries (State Council, 2005). Although there is no official promotion for ISD, the ISD can be understood as a sub-branch of RCR and CE development as there is no emphasis on inter-organisational collaborations in the latter two concepts.

The national targets and strategy for resource efficiency, energy conservation, and pollution reduction are formulated in the national government’s policy documents such as *Several Opinions of the State Council on Speeding up the Development of the CE Development* (2005), the *Comprehensive Strategy for Energy Conservation and Pollution Reduction* (2011), the *Guidance on RCR for the 11<sup>th</sup> and 12<sup>th</sup> Five-year Plans* (NDRC, 2006; 2011d), the *Implementation Plan on the Comprehensive Re-utilisation of Bulky Solid Waste Streams* (2011b), and the *12<sup>th</sup> Five-year Plan on the Comprehensive Re-utilisation of Bulky Industrial Solid Waste Streams* (2011a). The policy targets are expressed by a number of quantifiable indicators such as the rate of reuse of recycled materials or industrial solid waste or mineral by-products and energy consumption per 10<sup>4</sup>RMB GDP.

In responding to the above national policy documents, various policy instruments are formulated and adopted by a range of government departments in China. The following sections give an in-depth analysis of how the policy tools and target delivery landscape are deployed from the central government down to the regional level. The inadequacies of the Chinese policy framework are discussed by comparison with the UK's policies targeting similar goals.

### 3.1 Chinese policy instruments targeting resource efficiency and pollutants reduction

The policy instruments proposed in the Chinese Government's policy documents are a mixture of legislation, guidance, tax and funding projects as shown in table 1. The research considers key policy instruments relating targeting resource efficiency and pollutants reduction rather than policy instruments such as regulations relating to pollution prevention and waste shipment.

**Table 1 UK vs. Chinese key policy instruments**

<b>Instrument Type</b>	<b>UK</b> Targeting resource efficiency & landfill diversion	<b>China</b> Targeting resource efficiency & pollutants reduction
Regulation	1. Landfill ban (e.g. tyres) 2. Requirement to register with the EA according to regulations for WEEE, packaging and waste batteries	1. Catalogue of restricted and eliminated techniques, equipment, and material ( <b>Banning Catalogue</b> )
Levy	3. Landfill Tax 1996	
Stimulus		2. Preferential taxes (Corporate Income tax & Value-added tax)
Guidance	4. Waste Protocols Projects	3. Catalogue of promoted CE technology, technique and equipment ( <b>Promotion Catalogue</b> ) 4. List of technically innovative pilot CE projects
Funding	5. Funding Facilitation Programmes 6. Financing individual projects (e.g. Anaerobic Digestion plant)	5. Funding pilot projects (e.g. individual energy/water conservation, EIP/agricultural industrial park development, waste disposal, utilising large solid waste streams) (NDRC, 2011c)

Unlike there is a pressure upon landfill that has resulted from the landfill tax in the UK, there is no this type of tax. Landfill is the cheapest way of waste disposal option in China and the average landfill cost is round £4 per ton, much lower than any other disposal technologies (Zhang, Li, Hu, & Song, 2012). According to Wang and Zhang (2010), due to the limited level of RCR capacities, large quantities of industrial solid waste in China are directly transported to municipal solid waste landfill sites and have caused secondary pollution.

The mandatory regulation for resource and environmental target is the *Catalogue of restricted and eliminated techniques, equipment, and material (Restriction Catalogue)* listed in table 1. The restricted techniques are those found unsafe, causing pollution, and high resource/energy consumption (MIIT, 2010). According to the CE Promotion Law<sup>1</sup> (2009), the CED administrative department should collaborate with other ministerial government department to issue the *Restriction Catalogue* periodically, and different levels of fine will be imposed if enterprises violate the ordinance. However, through reviewing official documents relating to the *Restriction Catalogue*, two versions are found. One is the *Guiding Catalogue of eliminating outdated techniques, equipment, and products in several industries* (MIIT, 2010), and the sections of restricted and eliminated techniques in the *Guiding Catalogue of Restructuring Industries* (NDRC, 2011a). The two guiding catalogues are issued by different ministerial government department and a number of restricted or eliminated techniques are not consistent. For example, the former restricts iron-smelting furnaces with effective volume between 300m<sup>3</sup> and 400m<sup>3</sup> but the later restricts those with effective volume between 400m<sup>3</sup> and 1200m<sup>3</sup>. The *Restriction Catalogue* should have the potential to drive businesses to use good applicable techniques and equipment but the criteria issued by government departments should be consistent.

Besides the mandatory regulation, preferential tax policies are implemented in China. To receive a tax break, an enterprise's technology, techniques and equipment utilising by-products should meet the criteria of the *Promotion Catalogue* and the practice should be registered and assessed by the local RCR administrative department (MIIT, 2006). However, small businesses may therefore lack the financial capacity to introduce the promoted practices to enjoy the preferential taxes. Also, although the *Promotion Catalogue* is updated annually, the number of promoted technologies utilising waste resources is limited and cannot cover all ranges of RCR technologies. Therefore, businesses actually engaging with RCR activities cannot pass the assessment to get a tax break if their technologies are not covered in the *Promotion Catalogue*.

Incorporated into the above preferential tax policies, the *Promotion Catalogue* can drive capable enterprises to introduce the promoted RCR techniques, equipment and material. Moreover, the *List of Technically Innovative Pilot CE projects* aims to compile good technical practices working on building production chains for resource utilisation in heavy industrial networks and in industrial parks (MIIT, 2011b), and the first list was issued in 2012 covering 23 pilot CE projects (MIIT, 2012b). The catalogue can potentially guide inter-business IS activities, but so far, funding support for future innovative pilot CE projects is

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<sup>1</sup> The *CE Promotion Law* (2008) is a re-statement of the core preferential policies targeting the country's resource, energy and environmental goals as well as the legal notice about penalties on using outdated technique, equipment and material which bear the risk of high energy consumption and pollution.

unclear as it is a newly developed programme, and therefore, its impact to date has been limited.

The policy instrument is referred to by most of Chinese IS literature is developing EIP incorporating the IS concept. According to the State Council's policy document (2005), CE pilot projects should be promoted at key industries, industrial parks and cities to explore effective technologies and methods for resource, energy and environmental protection. Also, the government should support these pilot projects in terms of providing direct investment, grant funds, or subsidised loans. Besides providing funding support, in practice, local governments where EIPs are located have also worked on recruiting tenants to 'eat' local businesses by-products and developing sewage treatment plants and solid waste recycling facilities to enhance park-wide environmental service capacities (TEDA, 2006; Gao, 2010). During the process, the IS concept has been implemented to convert traditional industrial parks (or cities) into EIPs (or eco-cities). By 2012, China had developed 60 national pilot EIP projects since its commencement in 2001 (Zhao, 2012). Although the engagement with EIP development is entirely voluntary, cities compete to develop EIPs to promote their public images but are found to lack genuine environmental commitment to actually implement EIP development plans (Shi, Tian, & Chen, 2012).

Besides supporting the development of EIP projects, the government also committed to fund a range of technical, innovative individual RCR activities, infrastructure building for waste treatment and projects utilising large solid waste streams (NDRC, 2011c). These funds have a potential to mobilise businesses and regions to target resource efficiency and pollutants reduction. However, the scale of the supported subjects is restricted as the document (NDRC, 2011c) stresses the priority as supporting projects containing significantly innovative technologies. Lu *et al* (2010) study a range of central funds especially for environmental protection, and point out that there is insufficient attention on assessing project progress and effectiveness of using the funds and therefore problems emerged in the process of project implementation which cannot be effectively addressed in time.

### **3.2 The Chinese delivery landscape targeting resource and environmental goals**

By contrast to the UK, the delivery landscape of the Chinese policy instruments is largely government-led rather than the extensive involvement of non-government organisations (NGOs) to deliver government resource efficiency targets. At the national level, responsibility for promoting resource efficiency and pollutants reduction is split among the National Development and Reform Commission (NDRC), Ministry of Industry and Information Technology (MIIT), and the Ministry of Environmental Protection (MEP). The NDRC, a ministerial department commanding the national economic and social development strategies is in charge of RCR and CED promotion of the whole society (NDRC, 2012b); the

MIIT mainly promotes RCR and CED in industrial and information technology sectors (MIIT, 2012a); the MEP, a waste monitoring and enforcement ministry, is responsible for guiding and promoting CE, cleaner production and environmental protection industries (MEP, 2012a) through funding support on pollution reduction activities.

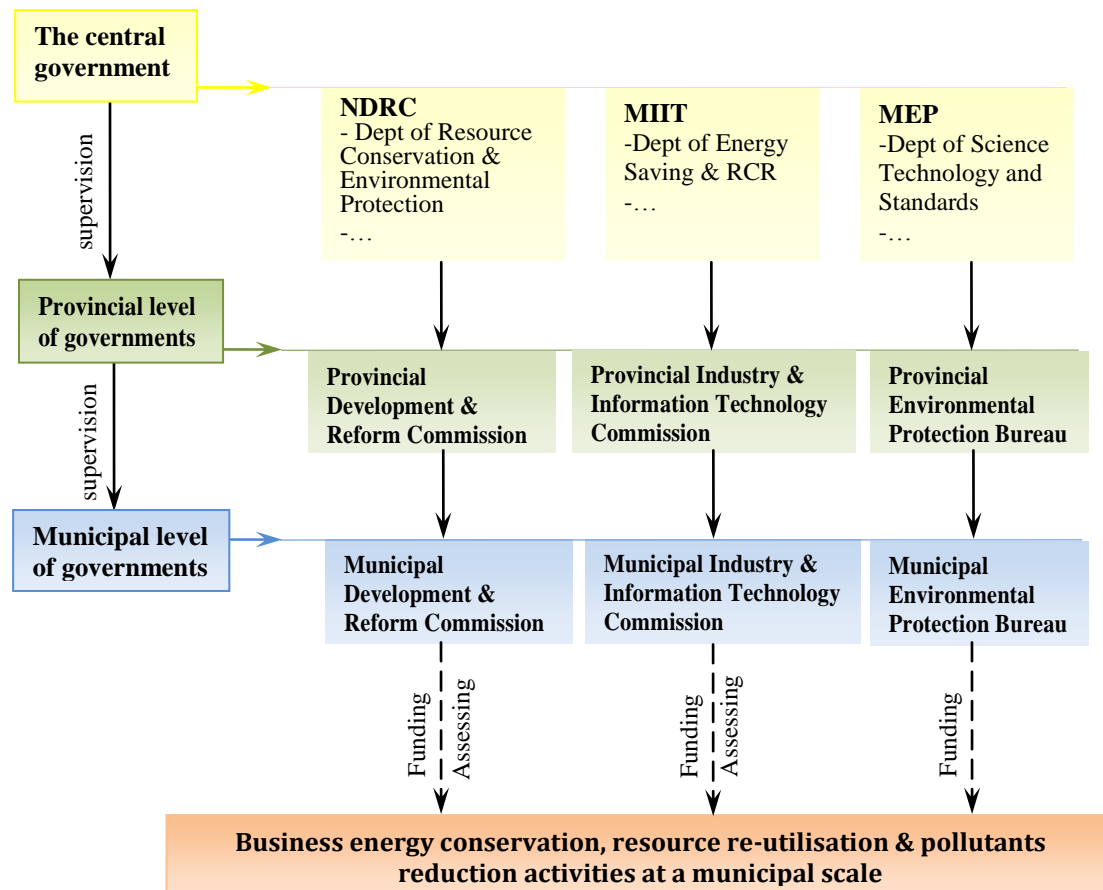


Figure 1 the Hierarchy of delivery landscape of RCR/CE

Compiled from NDRC (2012a), MIIT (2012c) and MEP (2012b)

At the sub-national level, the subordinate departments of NDRC, MIIT and MEP are responsible for delivering the regional and local targets through funding a number of pilot projects as mentioned in table 1. It is the NDRC initiated the assessment<sup>2</sup> of local industrial RCR activities but at the regional level, it can be either the subordinate of NDRC or that of the MIIT to deliver the assessment. Therefore, the institutional settings delivering the targets are not consistent from the national to local level.

The complicated delivery landscape for resource and environmental targets is due to a series of reforms of the central government structure and the gradual adaption of a lower level

<sup>2</sup> As mentioned in section 3.1, once businesses pass the assessment, they can enjoy certain tax break policies.



government structure. The central government structure reforms have covered the formation of the NDRC to replace the former State Development and Planning Committee (State Council, 2003), and later establishment of the MIIT to replace the former Ministry of Information Technology, and to take over the NDRC's industrial administration responsibility including promoting RCR and cleaner production in industrial and information technology sectors (State Council, 2008). During the process of reform, provincial governments had the autonomy to either establish new or use existent departments to operate under the NDRC and the MIIT (Jin, 2009), and this therefore resulted in an uneven national delivery landscape.

### **3.3 Achievements and Problems**

According to the review (NDRC, 2011a; MIIT, 2011) of the national RCR achievements between the 11<sup>th</sup> five-year periods, during 2005 to 2010, the re-utilisation rate of certain resources, such as mineral resources (35%), solid industrial waste (69%), fly ash (68%), smelting slag (60%) and agricultural straw (70%) have exceeded the proposed target set in the 11<sup>th</sup> year plan; secondly, the gradual technical innovations have increased effective utilisation of household electronic waste, textile waste and certain mineral waste; thirdly, policies for RCR activities have been improved with the recent introduction of the regulation and stimulus summarised in table 1; finally, there have been growing social benefits such as creating substantial job opportunities through RCR development. The report shows a positive progress of the national RCR development led by government. However, a number of points are needed to be clarified such as the source of the statistical data about resource re-utilisation rates, and the effectiveness of the funded pilot projects.

Given the Chinese policy instruments and delivery landscape targeting resource efficiency and pollutants reduction, four problems are identified: firstly, the lack of incentives for the reduction of landfill and businesses may not engage with RCR/CE activities if the landfill cost is lower than cost for other waste management activities. Secondly, fiscal incentives (both tax and funding resources) for SMEs' RCR/CE activities are limited due to the over-emphasis upon technical innovations of a limited number of RCR activities based on the annual updated Promotion Catalogue. Thirdly, compared to the UK, there is insufficient SMEs RCR/CE facilitation mechanism for utilising unwanted materials or energy. Fourthly, there are overlapping policy documents issued by the NDRC and the MIIT, and the responsibility boundary of their sub-national subordinate departments in promoting local resource efficiency is not clearly defined.

Generally, the government departments have played a crucial role in promoting technical innovations on RCR and CE activities including IS initiatives. Chinese policy makers and related enforcement authorities could learn from the experiences of other countries. Through

a process of lesson drawing, an exchange of information on the policies and practices of other nations could lead to the improvement of the national strategies for resource and environmental targets.

#### **4. The UK's performance-based devolution model for ISD**

In the UK, the Zero Waste Economy (ZWE) has been proposed as the Government's overarching goal to waste management, and is described as a longer-term vision to shift the current throwaway society through waste prevention, re-use, recycling and recovery, and disposal is the option of very last resort (DEFRA, 2011c). Instead of referring to generating no waste, the ZWE targets to waste nothing; specifically, the ZWE is characterised that resources are both financially and environmentally valued; one individual's waste is treated as another's resource; zero landfill may be realised over time; public are promoted to have new attitude to waste (DEFRA, 2010). To move towards the ZWE, improving resource efficiency and landfill diversion are adopted as key policy approach (DEFRA, 2012). Compared to China, the UK has a clearer policy context implementing ISD led by the UK's National Industrial Symbiosis Programme (NISP) assisting by a number of other policy instruments such as landfill ban, levy, guidance and funding support as shown in table 1. The following sections analyse how the UK performance-based decentralisation model for ISD has been organised and delivered.

##### **4.1 UK Policy Instrument for ISD**

Funded by government, NISP can be treated as a networking facilitating policy instrument for ISD. The financial support for the networks has been provided through the provision of the broker, NISP. The broker's performance which is crucial to secure future funding, is measured by the impact it has delivered, such as the tonnages of waste diverted from landfill (Agarwal & Strachan, 2007). Facilitating networking seems to promote trust among network members for inter-organisational collaboration, which is connected to generating innovations and mutual competitive advantages (Hanna & Walsh, 2002).

The UK Landfill Tax was introduced in 1996. Landfill site operators are required for registering with the UK's tax and custom department to pay the landfill tax for every tonnage of waste that is landfilled. However, the tax is passed to businesses and local councils on top of their normal landfill fees. Also, VAT is charged on the landfill fees and the landfill tax. The tax rate has increased annually since the introduction of the landfill tax in 1996 (Seely, 2009a). The increasing landfill tax has potentially pushed businesses in the UK to seek reduction, reuse and other waste management solutions, such as IS activities. For example, according to a representative of a waste management company, the landfill 'escalator' has the potential to allow non-landfill technologies to compete with landfill:

“At an £80/t landfill tax, the total cost of landfill would rise to approximately £100/t and at such levels it is considered that there are a number of alternative waste

treatment technologies (including mechanical biological treatment, anaerobic digestion and large thermal plants such as incineration with energy recovery) which are capable of operating at a lower total cost to users than landfill. Accordingly, there is an opportunity to target C&I (commercial and industrial) residual waste for disposal in non-landfill treatment technologies.” (MT Waste Management, 2011)

Besides adopting landfill tax and bans to divert business to other waste management options, the landfill tax has worked as a special funding resource to support business resource efficiency activities and programmes (such as WRAP<sup>3</sup> and NISP) to promote resource efficiency (Eunomia, 2008; Seely, 2009b).

The Waste Protocol Project (WPP) was launched in 2006 with the collaboration of the WRAP, the Environmental Agency (EA), DEFRA<sup>4</sup> and industry (Laidlaw, 2008). A variety of waste materials have been examined to establish if, and how, they can be fully recovered and turned into one or more alternative products. Until now, the waste resources studied have covered aggregates from inert waste, compost, anaerobic digestate, flat glass and 20 other waste streams (EA, 2012a). Achievements of the project include Quality Protocols which set out the end-of-waste criteria on how to make products from a range of waste streams allowing businesses to use the recovered products without waste management controls, and a statement that confirms to the business community the legal obligations they must comply with to use treated waste material (Laidlaw, 2008; EA, 2012a).

With the objective of exploring the end-of-waste status of a number of waste streams, the introduction of the Waste Protocols Project reflects the UK’s valuation of an accurate definition of waste, and what activities cause waste to cease to be waste. The role of an accurate definition of waste has been connected to the collection of precise information about the nature and volume of wastes arising, and the formation of appropriate waste options and strategies (Phillips et al., 1999; Jamasb & Nepal, 2010). Meanwhile, the clarification of certain activities ceasing waste status can guide businesses to try different options to reuse and recover waste to products which potentially promote IS activities among businesses.

## **4.2 UK Delivery Landscape for ISD**

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<sup>3</sup> WRAP refers to the Waste Resource and Action Programme. Launched in 2000 with government funding, the programme aims to help recycling take off in the UK and to create a market for recycled materials (WRAP, 2012). Unlike NISP focuses on promoting cross-industry resource efficiency, WRAP focuses on creating markets for recycled resources (DEFRA, 2009).

<sup>4</sup> DEFRA refers to the Department of Environment, Food and Rural Affairs. It is a government department in the UK (DEFRA, 2011a).

DEFRA is identified as the key national government department promoting resource efficiency and landfill diversion through financing and supervising a range of delivered partners to implement its ZWE goal. Under the control of DEFRA, a number of key organisations promoting the UK ISD are identified (see Figure 2).

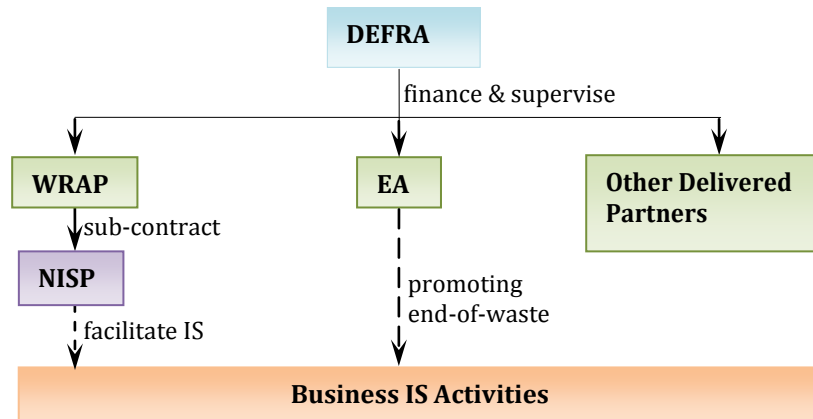


Figure 2 Key Organisations for ISD in the UK

Compiled from DEFRA (2011a)

The EA as a waste regulator has led the development of the guidance on the end-of-waste criteria to stimulate businesses to utilise waste streams to produce quality products, and the major motivation for the EA's involvement in resource efficiency promotion is the EA's objective to help producers and managers to treat waste as a resource and divert it away from landfill (EA, 2012a). Meanwhile, as an environmental regulator, the EA is responsible for providing general information and advice on complying with WEEE, packaging and waste batteries regulations for relevant producers who are required to register with the EA by these regulations (EA, 2012b).

NISP is a non-government organisation (NGO) delivered nationally by a number of environmental services organisations with government funding to facilitate business networking for ISD. Since 2010, the NISP is under the control of its previous parallel organisation, WRAP, to reduce customers' confusion by the myriad of services and bodies, and bring clarity for those seeking advice and support on resource efficiency (Letsrecycle, 2009). Seeking continued funding is one of NISP's key tasks (Mirata, 2004), but it was based on the generated outputs which were argued to be necessary to establish a method to quantify (Agarwal & Strachan, 2007). Since the initiation of the programme, NISP has paid high attention to establish a method to have its achievement quantified in terms of landfill diverted, CO2 reduction, hazardous waste eliminated, virgin material saved, water saved, cost savings to UK industry, private-sector investment attracted, and additional sales generated (relating to value created by utilising waste resources). Recording and calculating outputs are also

required by NISP funding bodies, maximising resource re-use and meeting associated funding targets are a priority for NISP (Jensen *et al.*, 2011).

In Britain, there has been a devolution of responsibilities to NGOs or so-called delegated agents, such as WRAP and NISP, with funding or other support from government since 1980s (Wettenhall, 1981 & 2005; Flinders, 2004). The NGOs are therefore given a certain degree of management autonomy which refers to the freedom to allocate resources to achieve given policy objectives (Laking, 2005). To some extent, using NGOs instead of government departments to provide certain public services, such as facilitating industrial resource efficiency, has been argued by Laking (2005) and Tan (2010) as a more efficient way to deliver better results as NGOs can be more focused on specific objectives and have the freedom to make management decisions without operating with multiple or unclear objectives and limited managerial freedom. However, for these delegated organisations, securing sustainable funding resources has been described to be the key problem for funded NGOs (Macmillan, 2011). Since 2008, the budget allocation for DEFRA has been seen a significant reduction in the money available for national business support for resource efficiency, and most public sector organisations are being forced to adjust to cuts in their funding. WRAP's budget will be cut by 37%, from £48 million in 2010/11 down to £30m in 2014/15. NISP receives the largest proportion of WRAP funding and its funding will be cut by 30% (Croner-i, 2012).

#### 4.3 Characteristics of the UK's model for ISD

With the development of the national waste policy instruments, there has been a significant achievement in commercial and industrial (C&I) waste management activities in England. Figure 3 compares the development of C&I waste management methods in different years:

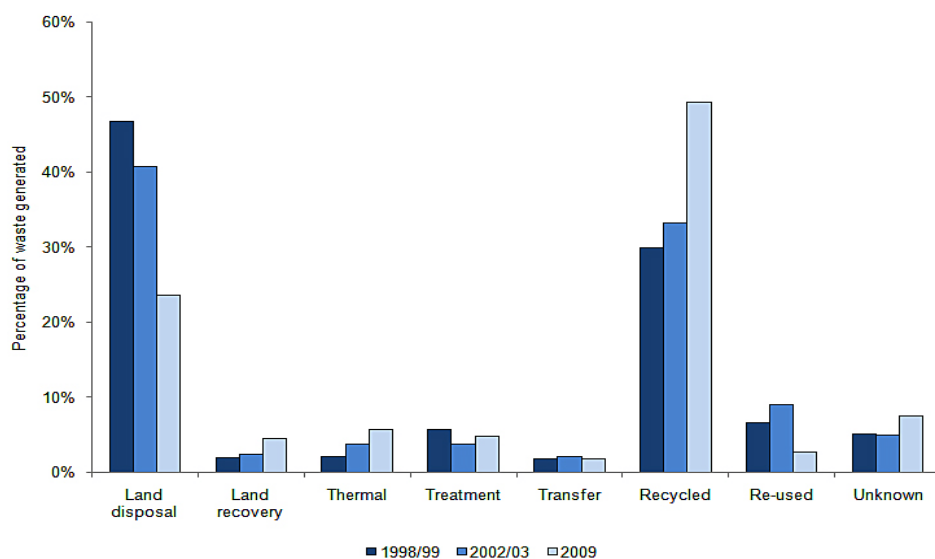


Figure 3. Management method as a percentage of total C&I waste, England, 1998/9, 2002/3, and 2009, Source: DEFRA (2011b)

According to DEFRA (2011b), in 2009, 52% C&I waste was recycled or reused in England compared to 42% in 2002/3; whilst, 24% of C&I waste was landfilled in 2009 compared to 41% in 2002/3. There has been a trend of decreasing landfill options and increased recycling activities on business C&I waste management activities in recent years. With regard to the sources of the statistic data, private consultancies were commissioned to undertake the national survey of C&I waste arising and management methods by DEFRA. The consultancies' method and data were externally evaluated and signed, and the details of the sampling and data analysis methods of the national survey are published (Jacobs, 2010).

Led by NISP, the funded cross-industrial resource efficiency facilitation programme, the UK's model for ISD is clearer compared to the Chinese policy context affecting ISD. The model integrates a number of inter-supported policy tools, such as the landfill tax, WWP projects, providing both "sticks" and "carrots" to businesses engaging in resource efficiency activities rather than landfill options. In terms of the delivery landscape, the UK's ISD model is decentralised to performance-based NGOs. However, there is huge uncertainty regarding this ISD delivery model as the funding is not permanent and is affected by the NGO's performance and the national financial environment.

## **5. Discussion: Lessons for China and prospects for successful transfer**

Swainson and Loe (2011) stress the importance of understanding the contextual factors for where the knowledge is currently in place. This research conducts an indepth analysis of Chinese and the UK's policy contexts targeting their resource efficiency and pollutants/landfill reduction goals. The Chinese model focuses on government's funding support, preferential tax and guidance to drive different levels (enterprise, park and city levels) of significant technical innovations on resource efficiency and pollutants reduction; whilst, the UK's model provides both "sticks" (e.g. landfill tax) and "carrots" (e.g. business facilitation programme and guidance) to businesses engaging in resource efficiency activities. Regarding the delivery structure of the UK's model, there is a decentralisation of the facilitation services to NGOs whose funding support relies on the short-/medium-term programme outputs.

The UK's performance-based devolution model for ISD is valuable for China in terms of its possibility to facilitate SMEs' resource efficiency activities, and to manage information exchange among the business networks. In China, as there has been the promotion of concepts such as RCR and the CED, when drawing upon the UK's model, it is necessary to

understand the UK's policy context and then consider how to integrate the ISD approach into the Chinese policy framework to meet its resource and environmental targets.

With regard to the extent of utilisation of the UK's model, it relies on the decision of Chinese central/regional government who would like to draw the UK's experiences as it is the recipient who should evaluate the quality and relevance of the received information (Wolman & Page, 2002). The policy knowledge utilisation can range from getting an inspiration to replication as described in section 2. The inspired points can be (1) giving pressure to business to divert landfill; (2) using "the tonnages of waste diverted from landfill" rather than the "pollutants reduction rate" as an important environmental protection assessment indicator; (3) clarifying the responsibility boundary of the MIIT and the MEP and their subordinates. The MEP's responsibility can be set to provide businesses with guidance to treat waste as a resource and divert it away from landfill, to advise businesses about methods to obey certain resource efficiency regulations, and to monitor waste activities; whilst, the MIIT's responsibility could be encouraging industries to engage in resource efficiency activities; (4) opening up the resource efficiency data collection and calculation methods rather than only publishing the statistical data.

Policies like landfill tax that have clear objectives and operational methods can be comparably more easily transferred than other policies. According to Rose (1993), Linos (2006), and Swainson and Loe (2011), a better theorised and explicit policy form can be easier to transfer to a new location.

Fully replicating the UK's ISD policy model could be more difficult as this is related to who is the appropriate organisation to bear the similar responsibility of the UK NISP, a NGO which relies on short- or middle- term government funding. If using a government department to take the responsibility of NISP, the best choice is likely to be the subordinate departments of MIIT rather than that of the MEP due to the environmental administrative department's focus on regulating waste, and industries will be reluctant to provide waste data to environmental regulators. Moreover, if a government department starts to operate the IS programme, a key barrier is the Chinese inflexibility on civil servant recruitment as in China, there shall be established posts for newly recruited civil servants and jobs for civil servants are usually supposed to be permanent (Chan & Li, 2007). There is a need for the government to either establish a delivery organisation which can be controlled by the government but has the autonomy on personnel management and can recruit people with profound industrial experiences to commit to the programme. Alternatively, a non-government organisation could be commissioned to deliver the programme with funding support but the mechanism to select the delegated organisation needs to be explored.

Generally, the UK's ISD devolution model can provide lessons to China but the extent of policy utilisation relies on the Chinese decision makers. It is important to consider Chinese policy and political factors to adapt the UK's policy elements.

## Academic References

- Agarwal, A., & Strachan, P. (2007). *The UK NISP: Towards Developing a New and Integrative Methodology to Evaluate IS Networks*. Retrieved May 10, 2012, from <http://www2.rgu.ac.uk/abs/National%20Industrial%20Symbiosis/Presentation.pdf>
- Benson, D., & Jordan, A. (2011). What Have We Learned from Policy Transfer Research? Dolowitz and Marsh Revisited. *Political Studies Review*, 9, pp. 366-378.
- Bulmer, S., & Padgett, S. (2004). Policy Transfer in the European Union: An institutionalist perspective. *British Journal of Political Science*, 35, pp. 103-126.
- Bulmer, S., Dolowitz, D., Humphreys, P., & Padgett, S. (2007). *Policy Transfer in the European Union*. London: Routledge.
- Chan, H. S., & Li, E. S. (2007). Civil service law in the People's Republic of China: a return to cadre personnel management. *Civil service reform in Russia and China*, pp. 383-398.
- Chertow, M. (2008). "Uncovering" Industrial Symbiosis. *Journal of Industrial Ecology*, 11 (1), 11-30.
- Chertow, M. (2000). Industrial Symbiosis: Literature and Taxonomy. *Annual Review of Energy and the Environment*, 313-317.
- Costa, I., Massard, G., & Agarwal, A. (2010). Waste Management Policies for Industrial Symbiosis Development: case studies in European countries. *Journal of Cleaner Production*, 18 (8), 815-822.
- Deutz, P., & Gibbs, D. (2004). Eco-industrial Development and Economic Development: Industrial Ecology or Place Promotion? *Business Strategy and the Environment*, 13, 347-362.
- Dolowitz, D., & Marsh, D. (1996). Who Learns What from Whom: a Review of the Policy Transfer Literature. *Political Studies*, 44 (2), 343-357.
- Dolowitz, D., Hulme, R., Nellis, M., & O'Neil, F. (2000). *Policy Transfer and British Social Policy: Learning from the USA?* Buckingham: Open University Press.
- Gao, J. (2010, 11). *Approach to New Industrial Development for Wuxi New Zone (Chinese)*. Retrieved 4 18, 2011, from Environmental Protection Department of Jiangsu Province: [http://www.jshb.gov.cn/jshbw/xwdt/sxxx/201011/t20101126\\_164310.html](http://www.jshb.gov.cn/jshbw/xwdt/sxxx/201011/t20101126_164310.html)
- Gereffi, G. (1995). Global Production Systems and Third World Development. In B. Stallings (Ed.), *Global Change, Regional Response: The New International Context of Development* (pp. 100-142). New York: Cambridge University Press.
- Gertler N. (1995). Industrial ecosystems: developing sustainable industrial structures. Massachusetts Institute of Technology.
- Gibbs, D., & Deutz, P. (2005). Implementing industrial ecology? Planning for eco-industrial parks in the USA. *Geoforum*, 36 (4), 452-464.
- Hanna, V., & Walsh, K. (2002). Small Firm Networks: A Successful Approach to Innovation? *R&D Management*, 32 (3), pp. 201-207.
- Jacobs. (2010). *Commercial and Industrial Waste Survey 2009, Final Report*. Retrieved May 25, 2012, from Defra: <http://archive.defra.gov.uk/evidence/statistics/environment/waste/documents/commercial-industrial-waste101216.pdf>
- Jamasb, T., & Nepal, R. (2010). Issues and Options in Waste Management: A Social Cost-benefit-analysis of Waste-to-energy in the UK. *Resource, Conservation and Recycling* (54), pp. 1341-1352.
- Jensen, P., Basson, L., Hellawell, E., Bailey, M., & Leach, M. (2011). Quantifying 'geographic proximity': experiences from the United Kingdom's National Industrial Symbiosis Programme. *Resources, Conservation and Recycling*, 55 (7), 703-712.
- Jin, J. (2009). Analysing Reforming Situation of National Administrative Departments in Charge of Informatization (Chinese). *Informatization Construction* (12).
- KimDowon, & PowellC.J. (2008). Comparison of Eco-Industrial Development between the UK and Korea. Proceedings of the EUKorea Conference on Science and Technology, 443-454.
- Laking, R. (2005). Agencies: Their Benefits and Risks. *OECD Journal on Budgeting*, 4 (4), pp. 7-25.
- Laybourn, P., & Morrissey, M. (2009). *National Industrial Symbiosis Programme: The Pathway to A Low Carbon Sustainable Economy*. International Synergies Ltd.
- Linos, K. (2006). When Do Policy Innovations Spread? Lessons for Advocates of Lesson Drawing.



*Harvard Law Review* , pp. 1467-1487.

Lu, Y., Wu, S., & Zhu, J. (2010). Study on Optimisation for Central Financial Special Fund of Environmental Protection. *China Population, Resources and Environment* .

Luo, Q., Catney, P., & Lerner, D. (2009). Risk-based Management of Contaminated Land in the UK: Lessons for China? *Journal of Environmental Management* , 1123-1134.

Macmillan, R. (2011). 'Supporting' the voluntary sector in an age of austerity: the UK coalition government's consultation on improving support for frontline civil society organisations in England. *The Policy Press* , 115-124.

Marsden, G., & Stead, D. (2011). Policy Transfer and Learning in the field of transport: A review of concepts and evidence. *Transport Policy* , 492-500.

Mirata, M. (2004). Experiences from Early Stages of A National Industrial Symbiosis Programme in the UK: Determinants and Coordination Challenges. *Journal of Cleaner Production* , 967-983.

Paquin, R., & Howard-Grenville, J. (2009). Facilitating Regional Industrial Symbiosis: network Growth in the UK's national industrial symbiosis programme. In F. Boons, & J. Howard-Greville (Eds.), *The Social Embeddedness of Industrial Ecology* (pp. 103-128). Northampton: Edward Elgar Publishing.

Phillips S., Read, A. D., Green, A. E., & Bates, M. P.P. (1999). UK Waste Minimisation Clubs: A Contribution to Sustainable Waste Management. *Resource, Conservation and Recycling*, 217-247.

Rose, R. (2005). *Learning from Comparative Public Policy: A Practical Guide*. London: Routledge.

Rose, R. (1993). *Lesson Drawing in Public Policy: A guide to learning across space and time*. Chatham, NJ: Chatham House.

Seely, A. (2009a). *Landfill tax: introduction and early history*. Retrieved from <http://www.google.com.hk/url?sa=t&rct=j&q=Landfill+tax%3A+introduction+and+early+history&source=web&cd=1&ved=0CFYQFjAA&url=http%3A%2F%2Fwww.parliament.uk%2Fbriefing-papers%2FSN00237.pdf&ei=YALhT9mjDYN8QOk9YSVDw&usg=AFQjCNFFD1hziAoKz8FDLPz8-sqPzCaf7w>

Seely, A. (2009b). *Landfill tax: recent developments*. Retrieved from <http://www.google.com.hk/url?sa=t&rct=j&q=Landfill+tax%3A+introduction+and+early+history&source=web&cd=2&ved=0CFoQFjAB&url=http%3A%2F%2Fwww.parliament.uk%2Fbriefing-papers%2FSN01963.pdf&ei=YALhT9mjDYN8QOk9YSVDw&usg=AFQjCNEEgkWdjux9hGNMUhhoY4bCeB87pw>

Shi, H., Tian, J., & Chen, L. (2012). China's Quest for Eco-industrial Parks, Part I: History and distinctiveness. *Journal of Industrial Ecology* , 16 (1), pp. 8-10.

SwainsonRebecca, & LoeC.deRob. (2011). The Importance of Context in Relation to Policy Transfer: A case study of environmental water allocation in Australia. *Environmental Policy and Governance*, 58-69.

Tan, K. (2010). Agencies: Rationale, Performance and Future. *Chinese Public Administration* , pp. 46-51.

Wang, S., & Zhang, S. (2010). Exploring the Environmental Monitoring of projects of General Industrial Solid Waste Landfill Sites (in Chinese). *Environmental Protection and Circular Economy* (6).

Wolman, H., & Page, E. (2002). Policy Transfer among Local Government: An information-theory approach. *Governance* , 15 (4), 477-501.

Zhang, X., Li, L., Hu, H., & Song, Y. (2012). Comparisons and Analysis on International Resource Recycling: A case study of waste disposal and recycling between China and Japan. In M. e. al. (Ed.), *Design for Innovative Value Towards a Sustainable Society*.

## Official Documents

DEFRA. (2010). *Background Information*. Retrieved 9 27, 2011, from DEGRA: <http://archive.defra.gov.uk/corporate/consult/waste-review/100729-waste-review-background.pdf>

DEFRA. (2011a). *DEFRA's Arms Length Bodies Network 2011*. Retrieved 2 10, 2012, from DEFRA: <http://archive.defra.gov.uk/corporate/about/with/delivery/landscape/documents/defra-network-landscape.pdf>

DEFRA. (2011b). *Commercial and Industrial Waste Generation and Management*. Retrieved Oct 17, 2011, from DEFRA: <http://www.defra.gov.uk/statistics/environment/waste/wrfg03-indcom/>

DEFRA. (2011c). *Government Review of Waste Policy in England 2011*. Retrieved 9 27, 2011, from <http://www.defra.gov.uk/publications/files/pb13540-waste-policy-review110614.pdf>

DEFRA. (2009). *Resource Efficiency Delivery Landscape Review*. London: DEFRA.

DEFRA. (2012). *Sustainable Business and Resource Efficiency*. Retrieved May 24, 2012, from Defra:

- <http://www.defra.gov.uk/environment/economy/business-efficiency/>
- EA. (2012a). *Waste Protocols Project*. Retrieved March 25, 2012, from EA: <http://www.environment-agency.gov.uk/business/topics/waste/32154.aspx>
- EA. (2012b). *Waste electrical and electronic equipment*. Retrieved from EA: <http://www.environment-agency.gov.uk/business/topics/waste/32084.aspx>
- Laidlaw, S. (2008). *Waste Protocols Project*. Retrieved March 25, 2012, from SEPA: [http://www.google.co.uk/url?sa=t&rct=j&q=&esrc=s&source=web&cd=3&ved=0CEUQFjAC&url=http%3A%2F%2Fwww.sepa.org.uk%2Fwaste%2Finformation\\_\\_resources%2Fevents%2Fprevious\\_events%2Fdoc.ashx%3Fdocid%3D7893a047-47d7-4d51-9144-9e19c0e15bc6%26version%3D-1&ei=94lvT\\_](http://www.google.co.uk/url?sa=t&rct=j&q=&esrc=s&source=web&cd=3&ved=0CEUQFjAC&url=http%3A%2F%2Fwww.sepa.org.uk%2Fwaste%2Finformation__resources%2Fevents%2Fprevious_events%2Fdoc.ashx%3Fdocid%3D7893a047-47d7-4d51-9144-9e19c0e15bc6%26version%3D-1&ei=94lvT_)
- MEP. (2012a). *Responsibility Description of Dept of Science Technology and Standards of the MEP (in Chinese)*. Retrieved from MEP: <http://kjs.mep.gov.cn/>
- MEP. (2012b). *Provincial Level of Environmental Protection Bureau (in Chinese)*. Retrieved from MEP: <http://www.zhb.gov.cn/>
- MIIT. (2006). *The Administrative Measures for the Determination of the RCU Encouraged by the State*. Retrieved May 19, 2012, from [http://www.gov.cn/zwgk/2006-09/13/content\\_387619.htm](http://www.gov.cn/zwgk/2006-09/13/content_387619.htm)
- MIIT. (2010). *Catalogue of eliminating outdated techniques, equipment, and products in several industries (in Chinese)*. Retrieved 6 19, 2012, from MIIT: [http://www.gov.cn/zwgk/2010-12/06/content\\_1760311.htm](http://www.gov.cn/zwgk/2010-12/06/content_1760311.htm)
- MIIT. (2011a). *12th Five-year Plan on the Comprehensive Re-utilisation of Bulky Industrial Solid Waste Streams (Chinese)*. Retrieved May 19, 2012, from MIIT: <http://www.miit.gov.cn/n11293472/n11293832/n12771663/14417035.html>
- MIIT. (2011b). *Notice about Organising and Recommending Technically Innovative Pilot CE Projects (in Chinese)*. Retrieved from MIIT: <http://jns.miit.gov.cn/n11293472/n11295091/n11299329/13569639.html>
- MIIT. (2012c). *Regional Administrative Department (in Chinese)*. Retrieved from MIIT: <http://www.miit.gov.cn/n11293472/index.html>
- MIIT. (2012a). *Responsibility Description of the MIIT (in Chinese)*. Retrieved from MIIT: Dept of Resource Conservation & Environmental Protection
- MIIT. (2012b). *The 1st Batch of Technically Innovative Pilot CE Projects*. Retrieved from MIIT: <http://www.miit.gov.cn/n11293472/n11293832/n11293907/n11368223/14542590.html>
- NDRC. (2011a). *Guiding Catalogue of Re-structuring Industries (in Chinese)*. Retrieved 6 19, 2012, from <http://www.ndrc.gov.cn/zcfb/zcfbl/2011ling/W020110427533127222579.pdf>
- NDRC. (2011b). *Implementation Plan on the Comprehensive Re-utilisation of Bulky Solid Waste Streams (Chinese)*. Retrieved May 19, 2012, from NDRC: [http://www.ndrc.gov.cn/zcfb/zcfbtz/2011tz/t20111229\\_453571.htm](http://www.ndrc.gov.cn/zcfb/zcfbtz/2011tz/t20111229_453571.htm)
- NDRC. (2011d). *the Guidance on RCR for the 12th Five-year Plan (in Chinese)*.
- NDRC. (2011c). *Notice about the Organisation of Applying for 2012 Central Budget Supported Resource Conservation and Environmental Protection Projects (Chinese)*.
- NDRC. (2012a). *Regional Development and Reform Commission (in Chinese)*. Retrieved from NDRC: <http://www.sdpc.gov.cn/dffgw.htm>
- NDRC. (2012b). *Responsibility Description of the Dept of Resource Conservation & Environmental Protection of NDRC (in Chinese)*. Retrieved from NDRC: <http://hzs.ndrc.gov.cn/newjgsz/default.html>
- State Council. (2003). *State Council Reform Plan (Chinese)*. Retrieved from [http://www.gov.cn/test/2009-01/16/content\\_1207006.htm](http://www.gov.cn/test/2009-01/16/content_1207006.htm)
- State Council. (2005). *Several Opinions of the State Council on Speeding up the Development of the Circular Economy Development (Chinese)*. Retrieved May 17, 2012, from <http://www.print-credit.com/ewebeditor/UploadFile/2008721213451621.pdf>
- State Council. (2008). *State Council Reform Plan 2008*. Retrieved from gov.cn: [http://www.gov.cn/test/2009-01/16/content\\_1207014.htm](http://www.gov.cn/test/2009-01/16/content_1207014.htm)
- State Council. (2011). *Comprehensive Strategy for Energy Conservation and Pollution Reduction (Chinese)*.
- TEDA. (2006). *Approach to Implement Circular Economy Pilot Project in TEDA (Revised Edition in Chinese)*. Retrieved 4 18, 2011, from <http://202.99.99.30/ConInfoParticular.jsp?id=1522>
- The former State Economic and Trade Commission. (1996, 12). *Clarifying Several Questions about the Opinions on Further Promoting Resource Re-utilisation*. Retrieved 12 31, 2011, from <http://jdluqx.bokee.com/inc/%B9%D8%D3%DA%BD%F8%D2%BB%B2%BD%BF%AA%D5%B9%D7%CA%D4%B4%D7%DB%BA%CF%C0%FB%D3%C3%B5%C4%D2%E2%BC%FB.htm>
- The Standing Committee of the National Congress. (2009, Jan 1). *The Circular Economy Promotion Law of PRC*. Retrieved May 19, 2012, from <http://www.lawinfochina.com/display.aspx?lib=law&id=7025>

Tianjin EITC. (2012). *Responsibility Description of Tianjin EITC*. Retrieved from Tianjin EITC: <http://www.tjec.gov.cn/Template/FMIS/T/DetailList.aspx?ContentID=1291>  
WRAP. (2012). *About WRAP: a world without waste*. Retrieved from [wrap.org.uk: http://www.wrap.org.uk/content/about-wrap](http://www.wrap.org.uk/content/about-wrap)

## **News Report**

Croner-i. (2012, June). *NISP- a Good Return for Public Investment?* Retrieved May 2, 2012, from [croner-i.croner.co.uk: http://www.croner-i.croner.co.uk/croner-i/gateway.dll/ena-resources/ena-features/ena-features-content/ena-gold-features-wkid-201203231008460049-51681852?f=templates\\$fn=ena-frameset.htm\\$3.0](http://www.croner-i.croner.co.uk/croner-i/gateway.dll/ena-resources/ena-features/ena-features-content/ena-gold-features-wkid-201203231008460049-51681852?f=templates$fn=ena-frameset.htm$3.0)  
Eunomia. (2008). *'Biostabilisation' of wastes: making the case for a differential rate of landfill tax*. Bristol: Eunomia Research & Consulting Ltd.  
Letsrecycle. (2009). *WRAP to Lead Resource Efficiency Delivery Body*. Retrieved March 2, 2012, from [Letsrecycle.com: http://www.letsrecycle.com/news/latest-news/waste-management/wrap-to-lead-resource-efficiency-delivery-body](http://www.letsrecycle.com/news/latest-news/waste-management/wrap-to-lead-resource-efficiency-delivery-body)  
MT Waste Management. (2011, July 13). *New Landfill Tax Makes Energy from Waste More Attractive*. Retrieved March 19, 2012, from [MT Waste Management: http://www.mtwaste.co.uk/index.php/news/detail/new\\_landfill\\_tax\\_makes\\_energy\\_from\\_waste\\_more\\_attractive/](http://www.mtwaste.co.uk/index.php/news/detail/new_landfill_tax_makes_energy_from_waste_more_attractive/)  
Zhao, Y. (2012). *Actively Creating Demonstration Eco-Industrial Parks (Chinese)*. Retrieved May 24, 2012, from [environment-China.org: http://www.cenews.com.cn/xwzx/gd/qt/201203/t20120320\\_714303.html](http://www.cenews.com.cn/xwzx/gd/qt/201203/t20120320_714303.html)

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*Track 5c. Regional sustainability: economic development and industrial symbiosis*

**Policy Translation of Industrial Symbiosis**

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*Chinese whispers (a game): “one person whispers a message to another, which is passed through a line of people until the last player announces the message to the entire group. Errors typically accumulate in the retellings, so the statement announced by the last player differs significantly, and often amusingly, from the one uttered by the first”<sup>1</sup>. Meaning can be lost but also created in the retelling.*

**Abstract:** The development worldwide of policy programs to facilitate industrial symbiosis shows the ambition of governmental officials to bring about industrial symbiosis through policy intervention. Researchers have acknowledged this, while in the industrial symbiosis literature policy is often treated as a static object rather than a dynamic process. In addition, it lacks an assessment of the effects of policy on industrial symbiosis. This paper fills this gap. A conceptual framework is built to explore the link between policy and industrial symbiosis practice in terms of a process of translation of ideas. It also presents the outlines of a research agenda with three general propositions concerning the link between policy translation of industrial symbiosis and institutional context. A case study of Circular Economy in China is introduced to outline and illustrate the conceptual framework, which focuses on how the *Circular Economy* idea was incorporated into, and subsequently evolved as, a policy program.

**Key words:** Policy Translation; Industrial Symbiosis; Circular Economy; China

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<sup>1</sup> [http://en.wikipedia.org/wiki/Chinese\\_whispers](http://en.wikipedia.org/wiki/Chinese_whispers)

# 1 Introduction

The interlinked global issues of climate change, environmental deterioration and resource scarcity are at the heart of the field industrial ecology, which has been called the “science of sustainability” (Allenby, 1999). One of the core topics in this field is industrial symbiosis, the development of by-product exchanges among firms in regional industrial systems. The generic label of industrial symbiosis covers a variety of practices within and between countries that involve the linkage of industrial processes in regional industrial systems through the exchange of by-products and utility sharing.

One line of investigation seeks to develop insight into industrial symbiosis as a generic phenomenon. In that vein, scholars have:

- assessed relevant environmental or economic outcomes (e.g., Chertow and Lombardi 2005; Van Berkel, et al 2009; Jacobsen 2006; Martin, et al., 1998),
- analyzed social mechanisms of industrial symbiosis (e.g., Boons and Howard-Grenville, 2009; Boons and Spekkink, 2012; Domenech and Davies, 2011)
- proposed typologies of ways to stimulate industrial symbiosis development, such as policy, self-organization, middle-out approach, as well as emergent EIPs or planned EIPs (e.g., Chertow, 2007; Costa and Ferrao, 2001; Gibbs and Deutz, 2007; Baas, 2011).

An alternative line of research seeks to understand the variety of practices that are summarized under the label of industrial symbiosis (e.g., Van Berkel, et al., 2009; Mirata, 2004), which is seen as an idea can be adopted by firms and policymakers. The analysis deals with how the idea is adapted and transmitted among these actors. The so-called ‘translation’ perspective developed by Callon (1975; 1980; 1986), Latour (1986; 1992) and Czarniawska and Sevón (1996) provides a promising conceptual background for such studies, which analyze the travel of an idea. In this perspective, policies to promote industrial symbiosis are the product of policymakers translating the idea of industrial symbiosis, and the idea also travels with policy process, in which local actors translate the policy idea into industrial symbiosis practice.

The translation perspective differs from much existing research which tends to focus on policy content, instruments and relevant outcomes. In much of that work the process through which the

industrial symbiosis idea is (re)shaped and disseminated is missing. As Boons et al. (2011) argue more efforts should be devoted to identify the actual mechanisms of policy intervention on and diffusion of industrial symbiosis. The aim of this article is to conceptualize the link between policy and industrial symbiosis practices in terms of a process of translation of ideas. This provides a conceptual framework that enables the analysis of the way in which policy influence industrial symbiosis. In addition, translation perspective can enable the analysis of how idea travels between international, national, regional, and local levels, and the interactions between multilevel actors.

The paper is structured as follows. Section 2 summarizes the empirical and theoretical treatment of policy in industrial symbiosis literature. Section 3 then illustrates the theoretical framework, consisting of the policy translation concept, and local and trans-local translation processes, as well as their relation with institutional context and industrial symbiosis practice. In section 4 we use the evolution of the Circular Economy concept in China as a case to illustrate our conceptual framework. We explore how the Circular Economy idea was translated into China, and its main development at the national level over time, as well as how industrial symbiosis idea was translated into policy programs as part of the broader Circular Economy programs. Section 5 draws conclusions and proposes avenues for future research for a systemic and detailed investigation of the mechanisms of policy intervention and diffusion on industrial symbiosis.

## **2 Review of Policy Treatments in the Industrial Symbiosis Literature**

Policy is not a precise term as it is used differently by researchers depending on the purpose at hand (Heclo, 1972). Heclo (1972) defines policy as a course of (in)action rather than specific decisions or actions. Jenkins (1978) considers policy as a set of interrelated decisions, and Easton's systems approach (1953) emphasizes the web of decisions and actions. Based on Jenkins and Easton's, Hill (2005) proposes that policy consists of a course of actions or a web of decisions rather than a single decision, furthermore, policy invariably change over time. Based on Hill (2005), we define policy as: a pattern of decisions and actions in which a governmental body is involved, aiming to provide intentional guidance to the collective development of a particular area of concern. In this paper, we are interested in the ways in which policy activities are connected to industrial symbiosis practices, that is, the development of clusters of symbiotic

linkages. In the following part, we summarize the empirical and theoretical treatment of policy in industrial symbiosis literature.

## **2.1 Empirical Treatment**

With the uncovering of Kalundborg myth (Boons & Janssen 2004), industrial symbiosis became a fashionable topic that attracted worldwide attention. A variety of policy programs and practices were initiated taking the industrial symbiosis idea as an inspiration. In the industrial symbiosis literature, a number of empirical cases are frequently cited and studied. One of the familiar cases is the National Industrial Symbiosis Program (NISP) in UK. Triggered by successful industrial symbiosis practice in Humber region, the national government decided to expand industrial symbiosis projects into the whole UK (Mirata, 2004; Costa and Ferrao, 2010). Building on governmental support, NISP acted as a facilitator for industrial symbiosis practices through providing information, acting to make the market for by-products more transparent (Paquin and Howard-Grenville 2012). In The Netherlands, the national government developed a strong interest in stimulating industrial symbiosis practices (Boons and Janssen 2004; Deutz and Gibbs, 2008) under the name of sustainable industrial parks. The INdustrial Eco-System (INES) projects in Rotterdam Harbor, itself inspired and informed by the Kalundborg developments (Baas, 2005) became one of the two show-cases in the Dutch national policy document *Economy and Environment* with the aim of achieving win-win situation between economy and environment. In the U.S., the President's Council on Sustainable Development (PCSD) issued a report *Sustainable America: A New Consensus for Prosperity, Opportunity and a Healthy Environment for the Future* in 1996, in which the definition of EIP was given and the task force on EIPs was formed (Gibbs and Deutz 2005; Chertow 2007). In Asia, Japan was a pioneer country that made efforts on Eco-Town program characteristic of the integration of industrial symbiosis and urban symbiosis (Van Berkel 2009). During 1997 and 2006, totally 26 plans were approved (Van Berkel, et al., 2009). Beyond the four mentioned cases, there is a variety of policy programs worldwide relevant to industrial symbiosis. Table 1 gives a brief overview of policy programs that we have found in the scientific literature and relevant websites. These are all national policy programs that aim to directly facilitate industrial symbiosis practice (e.g. EIP), or explicitly took

industrial symbiosis practices as a useful methods to solve environmental problems (e.g. recycling, exchange or cooperation between firms in waste management policy).



Table 1 A brief overview of national-level policy programs worldwide

Continent	Country	Policy Program	Short Description
Northern American	U.S.	Sustainable America - Eco-industrial Park	The PCSD <sup>1</sup> issued the report in 1996, Sustainable America: A New Consensus for Prosperity, Opportunity and a Healthy Environment for the Future, in which definition of EIP was given and the task force on EIPs was formed.
	United Kingdom	National Industrial Symbiosis Program (NISP)	NISP was launched in 2003 and delivered at regional level, which was the first national-level industrial symbiosis program in the world. The program aimed to facilitate uniformity in the programs' development, meanwhile, stimulate communication and interaction among regions.
	Netherlands	Sustainable Industrial Parks (Duurzame Bedrijventerreinen-DBT)	The DBT program ran from 1999 to 2003 aiming to stimulate the development of sustainable industrial parks based on the exploration of possibilities for cooperation between firms in the industrial park and between firms and involved governments.
Europe	Sweden	Ecocycle Strategy Plan	In 1993, the Swedish Government appointed the Ecocycle Commission to develop a strategy for a closed-loop system at product perspective, one of the aims was to reclaim and recycle waste products.
	Germany	Act of Closed Substance Cycle and Waste Management (ACSCWM)	ACSCWM was issued in 1996. Towards a recycling economy, Germany achieved the highest recovery quotas worldwide as the Act.
	Finland	The National Waste Plan for 2016- Towards a Recycling Society	The plan includes principles and objectives of waste management and prevention of waste generation for 2016. In the plan, industrial symbiosis is suggested as ways to utilize by-products and waste.
	Portugal	The environmental Framework Act(EFA); the National Waste Management Plan(NWMP)	In EFA(1987), article 24 mentioned waste and its reuse/recycling as raw materials and energy. NWMP (2011-2020) identified industrial symbiosis as a key strategy to be pursued.
Asia	China	National Pilot EIP program(NPEIPP); National Pilot Circular Economy Zone Program(NPCEZP); Circular Economy Promotion Law	In 1999, SEPA <sup>2</sup> initiated NPEIPP and NPCEZP; In 2005, NDRC <sup>3</sup> took charge of NPCEZP, and issued a series of policy documents to facilitate and guide Circular Economy development (including EIPs). In 2008, Circular Economy Promotion Law was approved by Central Government and implemented in 2009.
	Japan	Eco-Town Program	The program was initiated in 1997 which integrated industrial symbiosis and urban symbiosis. During 1997 and 2006, totally 26 local plans were approved.
	South Korea	National Plan for Eco-Industrial Park	The program was launched in 2005 with three stages' objectives: the first stage was to evolve 5 demonstration pilot projects; the second stage was to extend to 20 EIPs; and the third stage was to develop 'own style' of EIPs with aims of maximizing reuse within each park and achieving zero emissions.
	Thailand	Eco-Industrial Estates Development (EIED)	In 2000 IEAT <sup>4</sup> initiated EIED supported by GTZ <sup>5</sup> . The project began with five pilot estates aiming to eventually achieve 28 eco-industrial estates, and then expanded to support networks of companies related to factories at the pilot estates.
	Philippines	Philippine National Development Plan for the 21st Century(PNDP); Private Sector's Participation in Managing the Environment (PRIME)	PNDP adopted the principles of industrial ecology which would guide the development of Philippine from 1999-2025. PRIME aimed to strengthen private sector participation in reducing environmental footprint of industry. One of the modules was about supporting cleaner production and waste minimization through the adoption of industrial ecology principle. <sup>2</sup>

<sup>2</sup> Note: 1. PCSD: President's Council on Sustainable Development; 2. SEPA: State Environmental Protection Administration of China; 2. NDRC: National Development and Reform Commission; 4. IEAT: Industrial Estate Authority of Thailand; 5. GTZ: the German technical development corporation.

Source: The data mainly generated from academic publications: Chertow, 2007; Gibbs, D. and P. Deutz. 2004; Paquin, R.L. and Howard-Grenville, J. 2012; Mirata 2004; Heck, 2006; Lehtoranta et al., 2011; Costa, et al. 2010; Van Berkel 2009; Kim 2006; Lowe, 2001 and Internet: [www.nisp.org.uk](http://www.nisp.org.uk); <http://www.kretsloppsradet.com/web/page.aspx?refId=179>; <http://www.chanrobles.com/administrativeorders/administrativeorderno385.html>; etc.

## **2.2 Conceptual and Theoretical Treatment**

In the literature on industrial symbiosis, there are three main topics under which policy is discussed: (1) Description of policy program and evaluation of its relevant impacts; (2) lessons learnt and policy implications; and (3) arguments for the role policy should play.

### **(1) Policy Program Description and Relevant Impacts**

One focus in the literature concerns the description of specific policy program or narratives of policy evolution over a certain period of time. This is sometimes combined with an analysis of the relevant impacts on initiatives. For example, Van Berkel and his colleges (2009) argue that the Eco-Town program in Japan was successful because of available investment subsidies, recycling-oriented legislation, accessible technological resources, and widespread environmental awareness. Costa et al. (2010) compare waste management policy and legislation in four European countries and evaluate their impacts. They find governments could facilitate industrial symbiosis development through setting an integrated policy instruments to influence market towards reuse and recycling, furthermore, different levels of governments should have different efforts, but with aligned aims. Based on the evaluation of EIPs performance standard issued by the Chinese State Environmental Protection Administration, Geng et al. (2008a, 2008b) find the indicators do not address the essence of EIP, and the principles of eco-industrial development and local realities are not taken into consideration. Mirata (2004) analyzes the national industrial symbiosis program in the UK, and finds that operations of companies, regional industrial history, peer pressure, regional coordinating body, and approaches of rising environmental awareness are important factors to the progress of the program. In this strand, policy and initiatives are treated as two correlated variables without the exploration of ways through which policy actions influence industrial symbiosis practices.

### **(2) Lesson Learnt and Policy Implications**

A second strand of literature provides prescriptions for policy makers built on one or a few in-depth case study or comparison between cases. For instance, through the investigation of Kalundborg evolution experience, Ehrenfeld and Gertler (2008) argue that a “middle-ground

approach” of policy intervention would be the best way to foster the development of interdependence between firms. When they compare the EIPs in the USA and Europe, Gibbs and Deutz (2007) propose that a pro-active policy can aid in the development of EIPs by encouraging exchanges in terms of identifying opportunities and creating the enabling conditions. Heeres et al. (2004) compare EIPs in the USA and the Netherlands, and put emphasis on the importance of active participation of firms in the EIP planning stage. Based on the theoretical model and empirical evidence, Domenech and Davies (2011) propose that a coordination body could supplement the long-term processes of trust building, generate learning, and define institutional framework. In this track we mainly find empirical studies with inferences about the role of policy that are not based in an understanding of the policy process.

### (3) Arguments for the role policy should play

Many researchers are interested in the role policy should play in facilitating industrial symbiosis practices. For instance, Chertow (2007) argues that policy should focus on the identification of industrial symbiosis opportunities, and assist in their development. Costa et al. (2010) state that policy could influence markets towards industrial symbiosis through specifying clear objectives and giving support, rather than through direct intervention. Veiga and Magrini (2009) argue that government policy is important in diffusing industrial symbiosis concept and principle, by providing legal support. Gibbs and Deutz (2007) suggest policy could help to identify commercial opportunities and make the conditions more favorable. Regarding the different development stages of industrial symbiosis, Chertow (2007) suggests that policy may help in: (1) bringing the existing or emerging exchange or information to light, and (2) giving assistances to the existing or emerging exchanges between firms, (3) providing incentives to new activities through identifying the “precursors to symbiosis”. Veiga and Magrini (2009) claim that at the beginning of eco-industrial development, policy involvement is a strength, while it turns out to be weakness in the long run.

Through the review of theoretical treatment of policy in industrial symbiosis literature, it is clear that most often policy is treated as a static object with objectives, contents, and instruments, rather than a dynamic process. Also, policy and industrial symbiosis practices are taken as two

co-variant variables, while the ways in which they are linked and the mechanisms through which policy influences industrial symbiosis are to a great extent missing. In next section, we provide policy translation theoretical framework that enables the exploration of the dissemination of policy idea and its intervention on industrial symbiosis practices.

### **3 Theoretical Framework**

#### **3.1 Policy Translation**

In policy science, several schools explore the dissemination phenomena of policy ideas and practices. One is the policy diffusion school. It focuses on finding patterns in the adoption of policy practices and ideas in sets of (governmental) actors, mainly through quantitative studies (Marsh and Sharman, 2009). That is, it focuses on the chronological and geographical patterns of policy adoption, and is weak in the dynamics that underly adoption (Mukhtarov, 2009). Another school studies policy transfer, and emphasizes agency and tracing process (Marsh and Sharman, 2009). The weak point of the transfer school is that it presumes that a policy idea is somehow transferred mechanically, without changing, during the process of movement of policies between jurisdictions, transfer agents and transnational networks (Mukhtarov, 2009).

The policy translation concept provides an alternative perspective for exploration of the dissemination phenomena of policy idea, as it emphasizes the interaction between actors (multi-level governments, organizations, or firms) and various interpretations and modifications of the idea to fit with local context. In our conceptual framework, we emphasize the dynamic interactions between policy and industrial symbiosis practice in terms of local translation, and horizontal and vertical translocal translation. Meanwhile, we put forward several propositions about the ways of how translation process influences industrial symbiosis practices.

The dissemination of an idea is not simple adoption in straightforward ways. Instead, it is appropriated, interpreted, selected on, resisted or modified, in one word: translated by involved actors in various ways (Czarniawska and Joerges, 1996; Pel, et al. 2012) that are non-linear,

iterative and complex (Fadeeva 2004). Quoting from Czarniawska and Joerges(1996) and Latour(1986), Fadeeva (2004) argues:

*“Broad institutional rules and practices are not simply applied but, to some extent, are modified, reformulated, reshaped, redefined, and in general terms, translated, every time they are taken up by organizations or individuals...Even the term “translation”, that describes the process of movement of ideas, implied not simply the process of diffusion but of active modification of the initial idea by an actor, often to the extent that the actively re-interpreted idea hardly resembles that initial one.”*

This also applies to ideas embodied in policy programs. Policy documents include problem definitions and solutions, are developed into decisions, programs and instruments. In writing, adopting, and implementing these, actors move the idea between different levels and locations of organizations in continuous process. In the process, the policy content will undergo quite some revision, even if each of the involved actors is allowed to slightly amend the policy (Freeman 2009; Pressman and Wildavsky 1973). The policy translation perspective provides a useful way to capture the fact that the policy content can be translated in different ways by different actors, and the actors all together influence the policy outcomes.

In the dissemination trajectory of industrial symbiosis idea, various political, public, economic and academic actors are involved, each with different expertise, resources and legitimacy. As a result, they have different perception, interpretation and modification of the same idea (Fadeeva 2004). For instance, the national government may translate industrial symbiosis as an environmental-economic-societal “win-win-win” activity, while local government may translate it as a way to get national subsidies, or take it as a regulation. Differently, NGOs may translate it into environmental protection initiatives, while firms may translate it as economic activities with funding and special support from local government.

In addition to the emphasis on actors, policy translation pays attention to the fact that it always embeds in local contexts. That is, the interpretation and modification takes place and is shaped within distinct local contexts, and cannot be understood outside there (Johnson and Hagstrom

2005). For instance, the industrial symbiosis concept is implemented in a variety of ways in different countries (Spekkink, 2012), and within the same country, the same national policy document is carried out differently more or less by different regions.

In this article, we adopt the concept of policy translation to analyze the phenomenon that an idea is temporally and spatially disembedded from the original context, incorporated into policy programs in the new context, where it is re-embedded and further influences actions. To capture the features of translation, we particularly emphasize the fact of changed ideas and meanings interpreted and modified by actors to make it perform in the new contexts. With the main line, local and translocal translation process are conceptualized and three propositions are generated in the following part.

### 3.2 Local Translation Process

Policy translation calls attention to the characteristics and interactions of involved organizations, as well as the local context in the policy process. Selected ideas go through local translation, or even translocal translation process. Based on the phase model of Czarniawska and Joerges (1996), the translation process goes through “idea→object→ action→institutions”(Fig.1), or “idea→ object→(translocal) idea → object→ action→institutions(Fig.2)”.

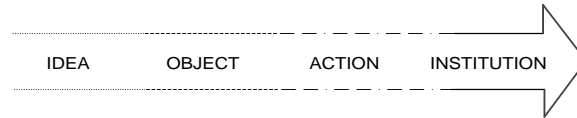


Fig. 1 Local Translation Process

In the local translation process, actors select ideas as solutions to solve defined problems. When an idea is objectified, it becomes a linguistic artifact, such as a policy document, a planning scheme, a design, etc. It can be followed by local action which implies the idea is been materialized and performed by human actors or material artifacts (Czarniawska and Joerges1996, p 41). Some ideas may stabilize into institutions; they become action patterns that are normalized and are taken for granted within an organizational field (Boons and Strannegard 2000; Czarniawska and Joerges1996). However, in most cases several phases take place simultaneously and continuously (Johnson and Hagstrom 2005).

### 3.3 Translocal Translation Process

Certain local objectified ideas can be transformed beyond local boundaries, that is, they are disembedded from their local context and reembedded within a new context (Czarniawska and Joerges 1996, p 26; Pel, et al. 2012). The idea might be present for a long time before it travels into a translocal space (Boons et al. 2000). The policy process thus covers multi-level governments and various actors. From local to translocal space, the policy translation can reveal a variety of patterns. We conceptualize them as two main translation patterns: vertical and horizontal translation (Fig.2). *Vertical translation* can occur in two directions: policy ideas disseminate from the national to the local level, and learning experiences that modify the idea flow from local level to higher levels, which mainly explains interaction between multilevel governments and various actors in the policy process. For example, in the Netherlands, the INES in Rotterdam Harbor became one of the two show-cases in the Dutch national policy document: Environment and Economy which aimed to facilitate local sustainable industrial parks. In general, the Dutch case illustrates two directions' translation. *Horizontal translation* concerns translation between regions or EIPs within different institutional contexts. For example, the INES project was inspired by Kalundborg (Baas, 2005). Another example are the international activities of NISP, which constitute horizontal translation at the level of nation states, including China, Mexico, Brazil, and United States, etc.

The ongoing process of translation consists of intertwined local, vertical and horizontal subprocesses. Together, they constitute a complex networking process with spatial and temporal features involving a wide arrange of actors that influence the results (Fig. 2). The most straightforward phenomenon is a national industrial symbiosis policy program which is translated by provincial governments, and subsequently translated by local industrial parks. During this course of events the idea embodied in the policy document is interpreted and modified to fit with the local context, and as a result policy change happens. Local actions and experiences feed back to regional and possibly to the national level where they may cause smaller or larger policy changes.

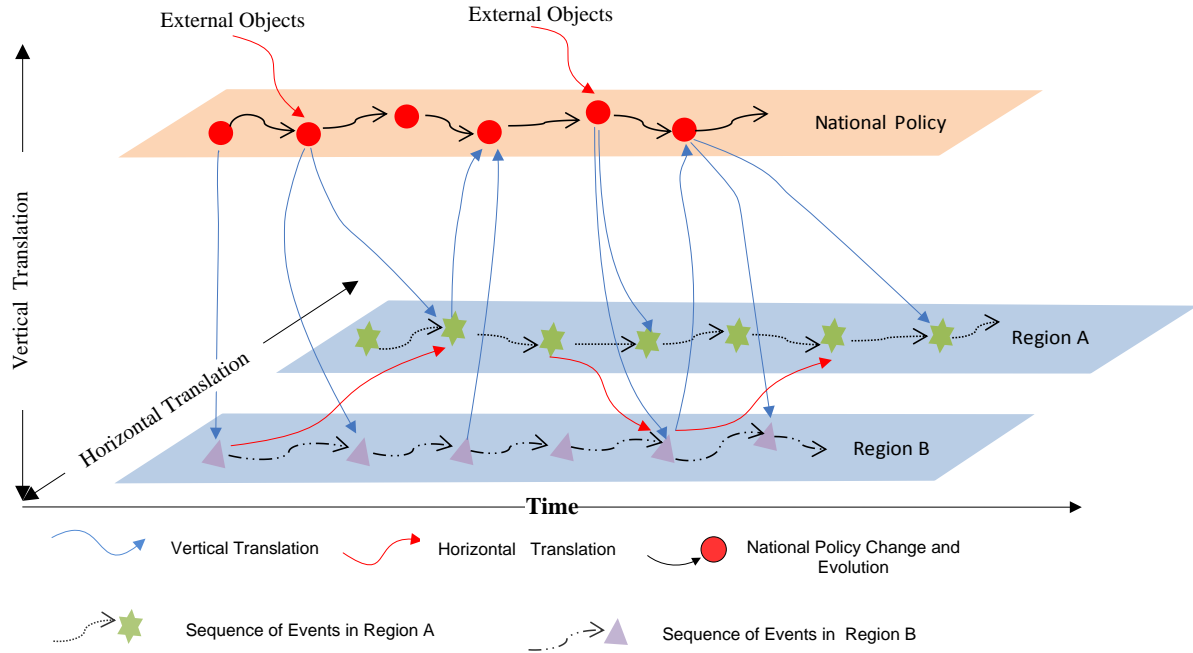


Fig. 2 Translocal Translation Process

### 3.4 Proposed Casual Mechanisms

Much of the translation process is about aligning the interests of actors (Latour, 2008, P 73), where all the involved actors influence the results of undertaking through the complex networking. The networking lays stress on the importance of cooperation between actors, which is necessary to achieve alignment. Actors with different organizational contexts and features have different expectations, interpretations, and translation of the same object-like policy program. The basis for cooperation is the fulfillment of their own interests, thus translation space is required. Translation space means that there is a sufficient level of flexibility and strategy adjustment for the involved actors (Fadeeva 2004), which is related to the objectified ideas : the transferability of the idea (Pel, et al., 2012), and is a function of the broad institutional context that generates general rules, relationships, and incentives for actions and interactions between actors. To combine policy translation with institutional context, we generalize three propositions about vertical, horizontal, and local policy translation.



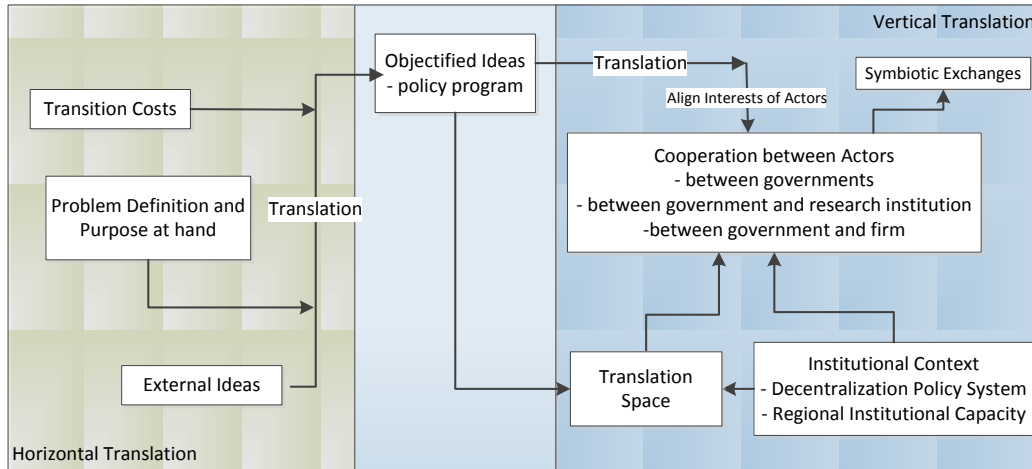


Fig. 3 Linkages among institutional context, policy translation, and industrial symbiosis practice

In vertical translation, the patterns of inter-governments relations and government-firm relations are embedded in a wider broad institutional context, such as politic, administration, history, culture, etc. To explain the mechanisms of vertical translation, we attempt to connect it with nation's policy system, which mainly points to the power and responsibility of national and local level in policy process. The mechanisms that connect policy system and policy translation can explain the varieties of interactions between multi-level governments of different countries.

In recent decades there is a tendency towards decentralization, which generally means dispersing governance closer to the local context and citizens. In a relatively decentralized system, ideas, policy programs, services can be more easily tailored to local context and much closer to local problems. Furthermore, local diversity allows more experimentation and innovation (Vries, 2000). As Vries (2000) claims, decentralization *"may result in better penetration of national policy to remote local communities, greater representation for various religious, ethnic and tribal groups in the policy process, and greater administrative capability at the local level. It can provide a structure in which local projects can be coordinated, it can enhance civic participation, and it may neutralize entrenched local elites, who are often unsympathetic to national development policies. It may result in a flexible, innovative and creative administration, it is more effective in its implementation, because of simplified monitoring and evaluation, it can increase political stability and national unity and it reduces diseconomies of scale: it is more efficient"*. As decentralization produces autonomy, local diversity, and participation of public, it could create more space and freedom for local translation. In addition, the role of firms in policy

process is taken into consideration largely which could lead to the higher willingness of firms to participate in industrial symbiosis practices.

*Proposition 1- vertical translation: The decentralized policy system can create more flexible translation space, which favors trust and cooperation building between actors and increased symbiotic exchange between firms.*

The impetus for translation comes from translators themselves. That is, their conception of situation, their self-identity and perception of other's identity, influences the translation (Sevon, 1996, P51). The conception of problems and purpose at hand lead translators to look for ideas and select certain ideas rather than others. When organizations perceive superior or more successful functions and activities, they accept, emulate, and learn from these activities (Scott 1995). Horizontal translation is a way of mimicry and learning from others' experience, and translating these experiences into ideas, objects and practices for own local use. It is a strategy that saves times and resources, as one does not have to use a trial-and-error strategy, or one may even avoid mistakes altogether (Sevon, 1996, P51). For industrial symbiosis practice, the saved times and resources in local governmental and EIPs' decision-making and actions could be taken as the reduced transition cost in stimulating and developing symbiotic exchanges among firms.

*Proposition 2- horizontal translation: Horizontal translation as a way of mimicking or learning from more successful actions can reduce local transition cost for decision-making and actions about stimulating and developing symbiotic exchanges among firms.*

It is often happened that within one county and same policy system, there is differences of local translation. Attempt to explain the differences between local translation, we propose to adopt the concept "regional institutional capacity", which is introduced and developed by Boons and Spekkink (Boons, et al., 2011; Boons and Spekkink, 2012) to analyze its influence on industrial symbiosis through altering opportunity set of actors. For certain region, the regional institutional capacity have impacts on local translations including searching, selecting, appropriating, modifying ideas from vertical or horizontal sources. The higher regional institutional capacity, such as experienced and well-qualified officials, local rich knowledge about industrial symbiosis, and high public awareness of environmental protection, has positive impacts on local translation,

such as easier to align interests of involved actors, and more efficient to stimulate symbiotic exchange between firms.

*Proposition 3 – local translation: The higher regional institutional capacity has positive impacts on alignment of involved actors and can stimulate symbiotic exchange between firms more efficiently.*

## **4 Policy Translation of Circular Economy in China**

In a policy translation perspective the following questions demand close attention in the empirical analysis of the dissemination of the industrial symbiosis idea in policy processes.

- *How is the idea reshaped during its travel: in terms of (1) conceptual content (problem definition and solution) and (2) process of bringing it about, that is, the course of actions to materialize the solution?*
- *How do different organizations/actors interpret and modify the idea and what change happens to the organizations/actors when they translate ideas into actions?*
- *How do different organizations/actors interact in horizontal and vertical policy translation process?*

The empirical part aims to illustrate the policy translation process based on a preliminary case study of national-level policy translation of Circular Economy in China, which particularly analyze the first question. We begin with an overview of the “Circular Economy” idea in Germany, Japan and Sweden, and then analyze the problems and pressure China has encountered in terms of environmental and economic development issues. We then explore the introduction of Circular Economy in China with a focus on its changing conceptual content, we conclude with preliminary conclusions about policy translation of industrial symbiosis in China. The data we use for this illustrative case are drawn mainly from secondary sources, including scientific articles, policy documents, and news reports.

### **4.1 “Circular Economy” in Germany, Sweden and Japan**

Germany and Japan are two countries where the idea of a “Circular Economy” has emerged and developed into policy at the national level (Xue, 2009; Peck 2006; Zhu, 2010; Zhu and Qian 2006). The idea also emerged in Sweden; however, it didn’t attract as much attention as that in Germany and Japan. Germany issued the *Act of Closed Substance Cycle and Waste Management* in 1996. Aiming to move towards a recycling economy, the Act emphasizes waste management, including the aspects of avoidance, recycling and environmentally sound disposal. As a result of the Act, Germany achieved the highest recovery quotas worldwide (Peck 2006). Chinese scholars name “Circular Economy” in Germany as “waste economy” as it places emphasis on waste management (Yong 2007). “Circular Economy” idea also showed up in Sweden under the label of “ecocycle”. In 1993, the Ecocycle Commission was appointed by Government, which aimed to limit environmentally hazardous products, and to a large extent reclaim and recycle waste product, and dispose the residual waste in environmentally acceptable ways. “Circular Economy” in Sweden is based on the product chain perspective, which is a difference with Germany. Japan is a pioneer Asian country that adopted the “Circular Economy” concept at the national policy level. In 2000, Japan issued the Fundamental Law for Establishing a Sound Material-Cycle Society. Accompanied with it, the Fundamental Plan for Establishing a Sound Material-Cycle Society was implemented, which included the contents of waste prevention, utilization of recycling resources, promotion of recycled goods, etc. (Peck 2006). Similarly, “Circular Economy” in Japan emphasized waste management like Germany (Zhu and Qian 2006).

#### **4.2 Problem Definition and Searching for Solutions**

China is a large, densely populated country undergoing rapid industrialization, and becoming one of the biggest consumers of natural resources worldwide. In developed countries, the process of industrialization has spanned a period of about 200 years, but the equivalent outcome has been achieved in a few decades in China (Fang, 2007). The traditional linear economic development model based on large amount of energy and resource consumption leads to serious resource scarcity and environmental pollution (Zhu, 2007). In addition to environmental pressures within the country, international pressure concerning on the consumption of resource, CO<sub>2</sub> emission and

climate change pushes the Central Government to search for a new economic development model to achieve a “leapfrog development”(Geng and Doberstein 2008) and improve national competitiveness (Feng and Yan 2007). With both the country-internal and international pressures, China’s development strategies changed from “development is the overriding importance” to “development is the top priority” and finally to “overall, sustainable, and harmony development”(Feng and Yan 2007). Under these circumstances, Chinese scholars and officials started to look for sustainable economic development models.

In 1998, Professor Zhu of Tongji University introduced the “Circular Economy” concept into China (Jin et al., 2010) through a series of publications (e.g. Zhu 1998a; Zhu 1998b). In these articles, the author introduced the German experience that was taken as a role model. Meanwhile, he explained the importance of the concept to Shanghai and China. In March 1998, the Shanghai official group of “China’s Agenda 21” and Shanghai Development Planning Commission went to Germany to learn of its experiences. In January 1991, the group approved the China’s Agenda 21 – Action Plan of Shanghai in which developing Circular Economy became one of the main regional development objectives (Xue 2009).

With the efforts of scholars like Zhu and Shanghai officials, the “Circular Economy” concept began to emerge in publications, governmental documents, and newspapers, in which the experiences of Germany and Japan were explained repeatedly (Xue 2009), particularly when the national government realized the importance of “Circular Economy”, and attempted to incorporate it into national development strategies and relevant policy programs. At the early stage of introduction, people used the labels “cycle economy”, “Circular Economy” and “recycling society” interchangeably and differently, just like the first several published articles by Zhu, where he used “cycle economy” and “Circular Economy” concept interchangeably. Gradually, “Circular Economy” has been widely accepted and selected as an appropriate term as the two concepts “recycling economy” and “cycling society” place emphasis on waste management, while “Circular Economy” has much broader meaning as it was not only a concept for waste management, but a new economic development model for China (Zhu and Qian 2006; Yong 2007). Circular Economy takes 3R (reduce, reuse, recycle) as basic principles. “Reduce” refers to reducing the amount of materials and energy usage and minimizing pollution in the

production process, which is treated as the first important principle by Chinese Central Government (Guideline for Circular Economy Planning, 2010). “Reuse” points to the exchanges of by-product and waste between firms. “Recycle” means using a product for many times in its primary state (Feng and Yan 2007; Jin et al. 2010).

### **4.3 Implementing ideas and Important Development**

This part presents the process of incorporating Circular Economy idea into national policy programs, as well as main developments afterwards at the national level through tracing Circular Economy actions initiated by State Environmental Protection Administration (SEPA), National Development and Reform Commission (NDRC), and Central Government.

SEPA was the first and leading national bureaucracy that became interested in and advocated the Circular Economy idea (Yong 2007). In 1999, SEPA started the first pilot EIP project: Guangxi Guigang Eco-industrial Park, and then facilitated other national pilot EIP projects, such as Tianjing High-Tech Eco-industrial complex, Suzhou Eco-industrial parks, etc. In 2002, Liaoning Province became the first National Pilot Circular Economy Zone. After that, Jiangsu Province, Shandong Province, as well as several provinces and cities were involved in the Program. In 2003, SEPA issued the policy documents: Application, Demonstration and Management of National Pilot EIPs (trial); Guideline for National Pilot EIPs Planning (trial); Application, Demonstration and Management of National Pilot Circular Economy Zone Program (Trial); Guideline of National Pilot Circular Economy Zone Program (Trial), aiming to stimulate EIPs and regional Circular Economy development. Several years later on these projects, SEPA organized a Pilot Circular Economy Projects Experience-Sharing Workshop in Tianjing High-Tech eco-industrial complex for the first time. The workshop was of crucial importance as experiences, difficulties, and problems were discussed and learned from these pilot projects. Furthermore, SEPA decided the next step for Circular Economy development in China after the workshop.

In 2004, NDRC organized a National Circular Economy Working Meeting in which Circular Economy was announced as an important element to be included in the National Eleventh Five-

year Plan, as well as Regional Eleventh Five-year Plan. Meanwhile, NDRC was appointed to take over the duty of promoting Circular Economy from SEPA, as Circular Economy has gradually become recognized as an economic rather than an environmental strategy (Yuan, 2006). In 2005 NDRC, SEPA and together with other four Ministries published the Promotion Plan for National Pilot Circular Economy Zone and the 1st Batch of National Circular Economy Pilot Projects, In 2007, NDRC issued the 2nd Batch of National Circular Economy Pilot Projects. The two batches of pilot projects covered regions (province, city), industrial sectors, EIPs, and enterprises, which showed that actions of Circular Economy in China covered three levels: eco-design and cleaner production at firm level (micro-level), industrial symbiosis at the inter-firm level (meso-level), and the development of eco-cities and eco-provinces at the social level (Geng and Doberstein 2008).

The second level of Circular Economy actions was mainly about EIP development which was supported by NDRC. At the same time, SEPA was also in charge of partial EIP Programs. For instance, in 2006 and 2007, SEPA published the policy documents: Assessment Standards for EIPs: (1) Standard for Sector-integrated EIPs, (2) Standard for Sector-Specific EIPs, (3) Standard for Venous Industry Based EIPs, and Management Method for the National Pilot EIP Programs. Therefore, two different coordination systems for EIPs currently exist, that is, some EIPs were approved and managed by SEPA, and some by NDRC, while 6 EIPs were guided both by SEPA and NDRC (Zhang 2010). The management systems of SEPA and NDRC are to a large extent different. For example, SEPA focuses more on pollutant reduction and energy conservation, while NDRC emphasizes resource efficiency. How to integrate and coordinate activities of SEPA and NDRC is still a question (Yong 2007). For detailed comparison of the two management systems, we refer to the article by Zhang, et al. (2010).

In the period of implementing Circular Economy idea by SEPA and NDRC, the Central Government also took actions. In 2002, the former President Jiang Zeming for the first time stated to promote Circular Economy, which meant including Circular Economy in the agenda making of national government (Yong 2007). In 2005, Several Opinions for Promotion of Circular Economy Development was issued by Central Government, in which the objectives for 2010 were decided. In 2006, Circular Economy as a new economic developing model was written in

the Eleventh Five-year Plan Outline for National Economic and Social Development. In 29 Oct. 2008, Circular Economy Promotion Law was approved at the 4th meeting of the State Committee of the 11th National People's Congress. The law identified the general principles, basic management rules, ways of reduction, reusing and recycling, incentive measures, as well as legal liabilities of Circular Economy development.

Through the chronological overview of Circular Economy introduction and development at the national-level in China, we present policy translation process including defining problem, looking for, objectifying, and materializing ideas, as well as the continuous and iterative policy translation process. In general, four preliminary conclusions can be drawn to understand policy translation of industrial symbiosis in China.

(1) The conceptual content was changed when “Circular Economy” idea translated from Germany to policy programs and actions in China. When scholars and officials introducing the idea, they realized the different context of China with Germany, such as development stages, and claimed that China can learn from Germany. At the same time, it was clear that “Circular Economy” in China should have Chinese features to solve China's problem. For instance, China is undergoing fast industrialization, which causes serious resource consumption and environmental pollution, thus the reduction of resource usage and environmental pollutant are the priority of actions. Therefore, the first principle of Circular Economy in China is “reduce”, and the first level action is cleaner production and eco-design at the firm level. For a post-industrialized country, like Germany, which is characterized by service- and consumption-oriented economy actions like cleaner production and environmental management system are already mature in these countries (Yong 2007). Thus the main focus for action is on waste management towards a recycling economy. At the beginning of introduction of the concept, confusions of word usage happened, such as recycling economy, cycle society, which reflects different interpretations of actors. The process from the confusion to the final decision of “Circular Economy” reflects the specific meaning that was created in Chinese Context.

(2) After the introduction of “Circular Economy” concept, there was an important generic change in interpretation and meaning-making over time. In 2004, NDRC was appointed to take over the



National Pilot Circular Economy Zone Program from SEPA. The reason was that after the pilot projects running for several years, the Central Government realized Circular Economy was not an environmental but economic concept (Zhang et al 2010). The event reflects that the meaning created by actors could be changed over time. The translation from local action and experience to national level is one of the important causes. For instance, based on the Pilot Circular Economy Projects Experience-Sharing Workshop, SEPA decided the next step of Circular Economy development in China.

(3) The industrial symbiosis idea was translated into Eco-industrial Park and Circular Economy Park, which is the second (meso) level of Circular Economy program. In 1999, SEPA first initiated Guangxi Guigang EIP project, and then several other EIP projects. In 2005 and 2007, NDRC issued the first and second batch of National Pilot Circular Economy Program, in which EIPs were part of it. At the early stage of EIP development, officials have blurred understanding about the appearance of an EIP and the criteria for the assessment of an EIP. Several years later of EIP experience, SEPA published Assessment Standards of EIP. The main development was the meaning-making process, which reflects the importance of the interaction between policy programs and practices.

(4) Various organizations with different institutional context have different interpretations about Circular Economy concept, and further influence their actions. For instance, SEPA and NDRC have different management systems about EIPs as they translate CE differently. For SEPA, pollutant reduction and energy conservation are the major concerns, while NDRC emphasizes resource efficiency.

## **5 Conclusions**

In this paper we present policy translation theoretical framework to capture the process and features of the travels of industrial symbiosis idea, particularly in the aspects of policy process and interactions between multi-level governments and actors. Policy translation emphasizes the fact that a policy idea is interpreted and modified by various actors differently to fit with organizational and local context. During the travels of an idea meaning can be lost and also be created in translation (Freeman 2009). The local, translocal translation processes provide ways of

tracing the diffusion and adoption of policy ideas which could be used to guide future empirical analysis of the dissemination phenomenon of industrial symbiosis idea. The proposed three propositions attempt to explain the casual mechanisms of institutional context, policy translation and industrial symbiosis practice, which are in the future research agenda.

Through the analysis of the national-level policy translation of industrial symbiosis in China, we find that the following points are important when conducting empirical analysis. Firstly, tracing and grasping the changing interpretation of the meaning of concept over time are necessary as it could further guide and influence relevant actions. Secondly, the changing translation over time could be understood through connecting it with institutional context. Thirdly, to understand various translations of different actors, the in-depth exploration of organizational field and organizational context are necessary.

The framework covers the basic concepts and general process of policy translation. Further research is necessary to gain systemic and detailed knowledge of how policy influences local industrial symbiosis practice. For this, we propose some avenues towards future research. First of all, it is important to dig deeper into the generic translation concept, including an understanding of associated theories such as actor-network theory and institutional theory (Boons, et al., 2000). Second, it is crucial to explore the drivers and mechanisms of actors' translation. Thirdly, several aspects may be interesting when adopt translation perspective to understand and explain pragmatic issues, such as multi-level interactions, interactions of different organizations and actors, and different translation of various organizations. Finally, the methodology for studying the translation process is important. We are currently working with process analysis based on the work of Poole and Van de Ven et al. (1989).

## References

- Allenby, B.R., 1999. *Industrial Ecology: Policy Framework and Implementation*. Upper Saddle River, NJ:Prentice-Hall.
- Baas, L., 2011. Planning and Uncovering Industrial Symbiosis: Comparing the Rotterdam and Östergötland Regions. *Business Strategy and the Environment* 20.
- Baas, L., 2005. *Cleaner Production and Industrial Ecology: Dynamic Aspects of Introduction and Dissemination of the New Concepts in Industrial Practice*.
- Boons, F., Howard-Greville, J., 2009. *The Social Embeddedness of Industrial Ecology*. Edward Elgar Publishing Limited.

- Boons, F., Janssen, M., 2004. The Myth of Kalunborg: Social Dilemmas in Stimulating Eco-industrial Parks, in Van den Bergh, J., Janssen, M. (Eds.), *Economics of Industrial Ecology*. Cambridge, MA: MIT Press, pp. 337-355.
- Boons, F., Spekkink, W., Mouzaktits, Y., 2011. The Dynamics of Industrial Symbiosis: a Proposal for a Conceptual Framework Based upon a Comprehensive Literature Review. *Journal of Cleaner Production* 19, 905-911.
- Boons, F., Strannegard, L., 2000. Organizations Coping with Their Natural Environment - A Laboratory for Institutionalization? *International Studies of Management and Organization* 30, 7-17.
- Boons, F., Spekkink, W., 2012. Levels of Institutional Capacity and Actor Expectation about Industrial Symbiosis: Evidence from the Dutch Stimulation Program 1999-2004. *Journal of Industrial Ecology* 16, 61-69.
- Callon, M., 1986. Some Elements of a Sociology Translation: Domestication of the Scallops and the Fishermen of St. Brieuc's Bay, in Law, J. (Ed.), *Power, Action and Belief: A New Sociology of Knowledge?*. London: Routledge & Kegan Paul, pp. 196-229.
- Callon, M., 1980. Struggles and Negotiations to Define What is Problematic and What is Not: The Sociology of Translation, in Knorr C.K., Korhn, R., and Whitely, R. (Ed.), *The Social Process of Scientific Investigation*. Boston, MA: Reidel, pp. 197-219.
- Callon, M., 1975. L'operation de Traduction, in Roqueplo, M. (Ed.), *Naissance Des Rapports Sociaux Sur Le Developpement Scientifique Et Technique*. Paris: CNRS, pp. 1-28.
- Chertow, M.R., 2007. 'Uncovering' Industrial Symbiosis. *Journal of Industrial Ecology* 11, 11-30.
- Chertow, M.R., Lombardi, D.R., 2005. Quantifying Economic and Environmental Benefits of Co-located Firms. *Environmental Science and Technology* 39, 6535-6541.
- Costa, I., Ferrao, P., 2010. A Case Study of Industrial Symbiosis Development Using a Middle-out Approach. *Journal of Cleaner Production*, 984-992.
- Costa, I., Massard, G., Agarwal, A., 2010. Waste Management Policies for Industrial Symbiosis Development: Case Studies in European Countries. *Journal of Cleaner Production* 18, 815-822.
- Czarniawska, B., Joerges, B., 1996. Travels of Ideas, in Czarniawska, B., Sevón, G. (Ed.), *Translating Organizational Change*, Berlin; New York; de Gruyter.
- Czarniawska, B., Sevón, G., 1996. *Translating Organizational Change*. Berlin; New York: de Gruyter.
- Deutz, P., Gibbs, D., 2008. Industrial Ecology and Regional Development: Eco-industrial Development as Cluster Policy. *Regional Studies* 42, 1313-1328.
- Domenech, T., Davies, M., 2011. The Role of Embeddedness in Industrial Symbiosis Networks: Phases in the Evolution of Industrial Symbiosis Networks. *Business Strategy and the Environment* 20, 281-296.
- Ehrenfeld, J., Gertler, N., 1997. Industrial Ecology in Practice: The Evolution of Interdependence at Kalunborg. *Journal of Industrial Ecology* 1, 67-79.
- Eston, D., 1953. *The Political System*. New York: Knopf.
- Fadeeva, Z., 2005. Translation of Sustainability Ideas in Tourism Networks: Some Roles of Cross-sectoral Networks in Change towards Sustainable Development. *Journal of Cleaner Production* 13, 175-189.
- Fang, Y., Cote, R.P., Qin, R., 2007. Industrial Sustainability in China: Practice and Prospects for Eco-industrial Development. *Journal of Environmental Management* 83, 315-328.
- Feng, Z., Yan, N., 2007. Putting A Circular Economy into Practice in China. *Sustainability Science* 2, 95-101.
- Freeman, R., 2009. What is 'Translation'? *Evidence & Policy* 5, 429-447.
- Geng, Y., Doberstein, B., 2008. Developing Circular Economy in China: Challenges and Opportunities for Achieving 'Leapfrog Development'. *Journal of Sustainable Development & World Ecology* 15, 231-239.
- Gibbs, D., Deutz, P., 2007. Reflections on Implementing Industrial Ecology through Eco-industrial Park Development. *Journal of Cleaner Production* 15, 1683-1695.
- Gibbs, D., Deutz, P., 2005. Implementing Industrial Ecology? Planning for Eco-industrial Parks in the USA. *Geoforum* 36.
- Heck, P., 2006. Circular Economy Related International Practices and Policy Trends: Current Situation and Practices on Sustainable Production and Consumption and International Circular Economy Development Policy Summary and Analysis.
- Heclo, H.H., 1972. Policy Analysis. *British Journal of Political Science* 2, 83-108.

- Heeres, R.R., Vermeulen, W.J.V., Walle, F.B., 2004. Eco-industrial Park Initiatives in the USA and the Netherlands: First Lessons. *Journal of Cleaner Production* 12, 985-995.
- Hill, M., 2005. *The Public Policy Process*, Forth ed. Longman.
- Jacobsen, N.B., 2006. Industrial Symbiosis in Kalundborg, Denmark: A quantitative assessment of economic and environmental aspects. *Journal of Industrial Ecology* 10, 239-255.
- Jenkins, W., 1978. *Policy Analysis*. London: Martub Robertson.
- Jin, Y., Feng, Z., Chen, D., 2010. Circular Economy: Ideas and Innovation. *China Academic Journal* 12, 5-11.
- Johnson, B., Hagstrom, B., 2005. The Translation Perspective as an Alternative to the Policy Diffusion Paradigm: the Case of the Swedish Methadone Maintenance Treatment. *Journal of Social Policy* 34, 365-388.
- Kim, 2006. Industrial Symbiosis Activities in Korea. , 31-33.
- Latour, B., 2008. Relativizing the Social, and the Becoming of Networks, in Anonymous Understanding Organization as Process: Theory for a Tangled World. Routledge: London and New York, pp. 59-77.
- Latour, B., 1992. Technology is society made durable, in Law, J. (Ed.), *A Sociology of Monsters: Essays on Power, Technology and Domination*. London: Routledge, pp. 103-131.
- Latour, B., 1987. *Science in Action: How to Follow Scientists and Engineers through Society*. Cambridge, MA: Harvard University Press.
- Latour, B., 1986. The power of associations, in Law, J. (Ed.), *Power, Action, and Belief*. London: Routledge and Kegan Paul.
- Lehtoranta, S., Nissinen, A., Mattila, T., et al., 2011. Industrial Symbiosis and the Policy Instruments of Sustainable Consumption and Production. *Journal of Cleaner Production* 19, 1865-1875.
- Lowe, E.A., 2001. *Eco-industrial Park Handbook for Asian Developing Counties*.
- Marsh, D., Sharman, J.C., 2009. Policy Diffusion and Policy Transfer. *Policy Studies* 30, 269-288.
- Martin, S.A., Cushman, R.A., Weitz, K.A., et al., 1998. Applying Industrial Ecology to Industrial Parks: An Economic and Environmental Analysis. *Economic Development Quarterly* 12, 218-237.
- Mirata, M., 2004. Experiences from Early Stages of a National Industrial Symbiosis Programme in the UK: Determinants and Coordination Challenges. *Journal of Cleaner Production* 12, 967-983.
- Mukhtarov, 2009. *The Hegemony of Integrated Water Resources Management: a Study of Policy Translation in England, Turkey, and Kazakhstan*.
- Nowak, K., 1992. Forskning om medier och kommunikation, in U. Carlsson and A. Lindblad (eds), *Forskning om journalistik, medier och kommunikation*, Goteborg: Nordicom, in U. Carlsson and A. Lindblad (Ed.), *Forskning Om Journalistik, Medier Och Kommunikation*, Goteborg: Nordicom ed.
- Pel, B., Teisman, G.R., Boons, F., 2012. Transition by translation: The Dutch traffic intelligence innovation cascade, in F.W. Geels, R. Kemp, G. Dudley & G. Lyons (Ed.), *Automobility in Transition? A Socio-Technical Analysis of Sustainable Transport*. Routledge Studies in Sustainability Transitions, London: Routledge., pp. 250-267.
- Pressman, J.L., Wildvasky, A., 1973. *Implementation: How Great Expectations in Washington are Dashed in Oakland* . Berkeley: University of California Press.
- Scott, R.W., 1995. *Institutions and Organizations*. London: Sage Publications.
- Sevon, G., 1996. Organizational Imitation in Identity Transformaiton, in Czarniawska, B., Sevon, G. (Ed.), *Translating Organizational Change*. Walter de Gruyter, Berlin, New York, pp. 51.
- Spekkink, W., forthcoming. Varieties of Industrial Symbiosis, in Pauline Deutz, Donald I. Lyons, and Jun Bi (Ed.), *International Perspectives on Industrial Ecology*.
- Van Berkel, R., Fujita, T., Hashimoto, S., et al., 2009. Industrial and Urban Symbiosis in Japan: Analysis of the Eco-Town Program. *Journal of Environmental Management* 90, 1544-1556.
- Van Berkel, R., Fujita, T., Hashimoto, S., et al., 2009. Quantitative Assessment of Urban and Industrial Symbiosis in Kawasaki, Japan. *Environmental science and technology* 43, 1271-1281.
- Van de Ven, A. , Angle, H., Poole, M.S., 1989. *Research on the Management of Innovation: The Minnesota Studies*. New York: Ballinger Publishing/Harper and Row.

- Veiga, L.B.E., Magrini A., 2009. Eco-industrial Park Development in Rio de Janeiro, Brazil: a Tool for Sustainable Development. *Journal of Cleaner Production* 17, 653-661.
- Vries, M.S.D., 2000. The Rise and Fall of Decentralization: A Comparative Analysis of Arguments and Practices in European Countries. *European Journal of Political Research* , 193-224.
- Xue, B., 2009. A study on the Developmental Mechanism of Regional Circular Economy.
- Yong, R., 2007. The Circular Economy in China. *Journal of Material Cycles and Waste Management* 9, 121-129.
- Yuan, Z., Bi, J., Moriguichi, Y., 2006. Circular economy: a New Development Strategy in China. *Journal of Industrial Ecology* 10, 4-8.
- Zhang, L., Yuan, Z., Bi, J. et al., 2010. Eco-industrial Parks: National Pilot Practices in China. *Journal of Cleaner Production* 18, 504-509.
- Zhu, D., 2009. Circular Economy 2.0: From Environmental Management to Green Development. Tongji University Press.
- Zhu, D., 1998. Circular Economy and Sustainable Development in Shanghai. *Shanghai Environmental Sciences* 17, 1-4.
- Zhu, D., 1998. Sustainable Development Appeals for Cycle Economy. *Science and Technology Review* 9, 39-42.
- Zhu, D., Qian, B., 2006. A Research on China's Circular Economic Development Mode and its Guarantee Syste. *Copper Engineering* , 6-10.

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**Track 5d**

5d: Planning and sustainability

**The Effectiveness and Feasibility Analysis of Low Impact  
Development Stormwater Management on Xiamen Island**

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**Introduction**

Urbanization is one of the results as the modern social development. As more and more people live in cities, more buildings are constructed. Therefore, impervious surface area increases which resulted in increasing surface runoff, decreasing groundwater recharge and base flow, and other environmental impacts (Dietz, 2007; Tang et al., 2005). Water resource protection at the local level is getting more complicated, largely due to the recognition of non-point source pollution, or polluted runoff, as a major problem. This diffuse form of pollution is derived from contaminants washed off the surface of the land by stormwater runoff, and carried either directly or indirectly into waterways or groundwater. Stormwater runoff will bring more problems as the increase of impervious surface area. In order to control stormwater runoff, many techniques have been applied. Low Impact Development (LID) is one of them. As the definition from the Unified Facilities Criteria, America (UFC, 2004):

Low Impact Development is a stormwater management strategy concerned with maintaining or restoring the natural hydrologic functions of a site to achieve natural resource protection objectives and fulfill environmental regulatory requirements.

A series of natural and artificial technologies are applied to infiltrate rain water, filter pollution, and reduce as much the impacts of stormwater on environment as possible.

LID provides not only environmentally sustainable tools but also new economically methods for local officials, the private sector and others to better address non-point pollution wet weather flow regulatory challenges for the protection of our receiving waters. Instead of the large investments in complex and costly centralized conveyance and treatment infrastructure, LID allows for the integration of treatment and management measures into urban site features. LID encourages the multifunctional cost-effective use of the urban green space, buildings, landscaping, parking lots, roadways, sidewalks, and various other techniques to detain, filter, treat and reduce runoff. LID is completely different from conventional management strategies.

Through LID's new advance technological tools it is possible to have better environmental protection for significantly less cost. The LID idea has been developed to many other ideas like LIUDD in New Zealand, WSUD in Australia, the SUDs in UK, etc.

Xiamen Island faces problems of the shortage of water and the pollution including surface runoff drainage to the sea associated with the rapid urbanization. Therefore, it is necessary to find out sustainable stormwater management which can effectively apply to the city development. In this study, a porous parking lot and an extensive green roof in the campus of Xiamen University has been selected as the study area and their effectiveness were tested.

## Case study

In this study, both of the two study areas located in the campus of Xiamen University. The porous parking lot was built on 2003 and has been used under high frequency since then. The green roof was built on 2004 and 2007 separately with different cover type. Six rain events were observed from January to May on 2008, and runoff samples were taken on both sites during the rain events and tested within 24 hours. The results show that both of these technologies can improve the local environment quality.

First, flood control ability. The LID practices can be relative effective in controlling peak discharge rates. Under the condition that the rainfall intensity  $<3.88 \text{ mm} \cdot \text{h}^{-1}$ , when the direct runoff appears on the grasspave pervious parking lot area, the time can delay up to 30 minutes relative to the impervious area. In general, as the study examined, the rainfall intensity will result a noticeable gain in precipitation retention. The infiltrations in the grasspave pervious area are hardly measurable, and greatly delay up to the time when the runoff appeared in the impervious and pervious area. Hydrologic improvements are smallest for large events and high antecedent water contents. The green roof can delay up to 200 minutes under the same condition. Even when the infiltration appeared, the flow rates of infiltration are very slowly. There no measurable runoff on the surface of the soil. This means the green roof have a high performance in infiltration and can retention a lot rainfall. The retention ability of green roof decrease as well as the rainfall intensity increase. When the rainfall intensity  $\leq 1.5 \text{ mm} \cdot \text{h}^{-1}$  the green roof has 100% retention of precipitation.

Second, pollution prevention and removal ability. The LID practices can effectively reduce and remove the pollutants from the runoff. The pH of runoff can be maintained between 7.5-8.0 after the pretreatment of the grasspave parking lot; the retention of total suspended solids only be 13.86%; Nitrogen behavior is complex because of the biogeochemical complexity of the nitrogen species. Ammonia capture is somewhat variable, with 39% removal,  $\text{NO}_3\text{-N}$  removal was good, at 76.55%; high concentration reductions ( $>60\%$ ) were found for zinc (Zn), copper (Cu) and lead (Pb); the



concentration of pollution in the infiltration are higher than the runoff. In general, this grasspave parking lot has good pollution control ability. The water quality of runoff from green roof is very good and can hardly influence the environment.

Third, using LID practices are feasible on Xiamen island. In terms of costs, LID techniques can reduce the amount of materials needed for paving roads and driveways and for installing curbs and gutters. But the use of LID techniques might not always result in lower projects costs. The costs might be higher because of the costs of plant material, site preparation, soil amendments, underdrains and connections to municipal stormwater systems, and increased project management. But the benefit of using LID techniques can be: reductions in pollutants, protection of downstream water resources, ground water recharge, reductions in pollutant treatment costs, reductions in the frequency and severity of CSOs, and habitat improvements, increases in real estate value, increased parcel lot yield, increased aesthetic value, and improvement of quality of life by providing open space for recreation. The environment condition of Xiamen Island is suitable for using the LID stormwater management strategies.

## **Conclusion**

Both of the two LID technologies can improve the local flood control and pollution prevention and reduction which pledge the prospect of its application in China. However, some problems may restrict the performance of them. First, the unqualified construction may decrease the technologies' effectiveness. Some parts of the construction do not meet the standards which is a common phenomenon in China. Second, routine maintenance is needed, such as soil amendment, preventing clogging, replacing vegetation after a long using, et al. Maintenance will ensure the facilities work well. Third, the limitation of the study areas and the study time period may not fully show the performance of these two technologies. It will be better to improve it and include the other LID technologies in the future study, so that the effectiveness and application of LID strategy in China can be fully explored. Finally, the cost of some facilities construction and maintenance are more expensive than the

conventional one which may constraint the development of these sustainable technologies. Fortunately, the China's government has made some policies that may greatly promote the development of them in the future.

## References

- Dietz, M.E. (2007) Low impact development practices: a review of current researches and recommendations for future direction. *Water air soil pollut*, 186: 351-363.
- Tang, Z., Engel, B.A., Pijanowski, B.C., Lim, K.J. (2005) Forecasting land use change and its environmental impact at a watershed scale. *Journal of environmental management*, 76(1): 35-45.
- Unified Facilities Criteria (UFC). 25/10/2004 *Design: low impact development manual*  
[http://www.lowimpactdevelopment.org/lid%20articles/ufc\\_3\\_210\\_10.pdf](http://www.lowimpactdevelopment.org/lid%20articles/ufc_3_210_10.pdf) viewed 14/03/2011 viewed 13/03/2008.

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## **Commercial waste management in Tripoli, Libya: present practice as a guide to identifying environmentally sound technologies**

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### **Abstract**

Municipal solid Waste management (MSWM) remains a problematic issue for many developing countries. The transfer of technology from developed countries has not typically been successful. The principle of 'Environmentally Sound Technologies' (EST) has been proposed as a guide to the selection of waste management practices that would work in a given setting. Selecting EST requires consideration not only of the institutional capacity of the service provider, but also the social and cultural norms of the service users. In Tripoli, the commercial waste ranks as the second largest waste generator after the residential sector. The quantity of commercial waste generated in Tripoli city is estimated by the waste department at the municipality to be about one-third of the total municipal waste output. The major sources of commercial waste in the study area include the formal trading and services activities such as mini shops, supermarkets (stores), hotels, restaurants, coffee shops; and maintenance and services workshops.

The aim of this study is to investigate the attitude and behaviour of owners and/or managers of commercial activities. To what extent do the existing solid waste storage, collection and transportation facilities meet their requirements? What changes to practice would they support?

A questionnaire survey was distributed to the city zones based on the administrative division that has been designed by the Tripoli municipality. The results obtained have been analysed to explore to what extent it could be argued that the current practices can meet ESTs principles. The study outcome indicates that facilities allocated for waste management in the commercial sector are to a great extent not compatible with the type and volume of

waste generated. It does not appear to be a priority of policy-makers to incorporate the commercial sector within their consideration of sustainable waste management.

Key words: Commercial waste; Libya, waste management, environmentally sound technologies, Tripoli.

## Introduction

The vast majority of developed countries have succeeded entirely in collecting solid waste generated from different sources and shifted their policies and strategies toward applying a sound technology in treatment options (Pires *et al* , 2011). In many developing countries, fulfilment of such a task is still elusive (Wilson *et al*, 2012), Many areas of cities and towns are left without regular waste collection service (Zurbrügg, 2003) or even have no collection service (Bhuiyan, 2010).

Adopting technologies to manage solid waste in a sustainable way requires an understanding of a number of factors to meet the requirements and preferences of the actors, whatever they are, especially in developing countries such as Libya, which depend heavily on foreign technologies for development. One of the important neglected factors, as Bernstein (2004) argued, is community considerations of social and cultural norms. These, he described as central to system design and implementation in order to meet the MSWM needs of a society. Therefore, he urged decision-makers to take steps to ensure the suitability of projects proposed by predicting the interaction of society with such projects. In this context, many developed countries have succeeded in including social considerations during project planning and implementation. However, in developing countries to a certain degree the choice of technology option even in storage, collection and waste transportation activities entirely depends on the view of waste service providers (Obeng *et al*, 2009). Therefore, the developing countries have a lot to do in order to improve SWM practices. In this sense, to facilitate access to the sustainable meaning of technology, within Agenda 21 of the United Nations, the international community proposed ESTs as a common policy for technology transfer and adoption. However, until now, the nearly four decades after its emergence, there is still misunderstanding of the EST concept. In this context, Diaz (2010) and van de Klundert & Anschutz (1999) pointed out that there are important aspects in equipment selection in terms of local cultural and socioeconomic considerations that are ignored completely or misunderstood, which in the end leads to the application of a system that is not accepted by the society to be served.

Carrying out recycling and recovery activities is carries both economic and environmental benefits. This is especially true for developing countries, where 'landfill' still commonly implies open dumps (Wilson *et al.*, 2012). Implementation of recycling technology, for example, has succeeded in many developed and some developing countries (Troschinetz & Mihelcic, 2009). However, the level of success is always dependent on the householders' participation (i.e.; how much they understand and respect the waste collection scheme). Local authorities often carry out recycling campaigns to raising awareness and educate the households on how to be a partner in their projects (Timlett & Williams, 2008). In this sense, while much work has been done in household participation in waste management schemes, relatively little attention has been paid to commercial premises. Recycling especially for dry waste generated from commercial sector has not become the norm in many developing

countries (Omran *et al*, 2009). In Libya, the government at national level spent over one third billion annually just to collect of municipal solid waste and dump it to landfill (Faras & Alqrau, 2004). This represents a lost opportunity for material recovery. Therefore, it has been suggested that the developing countries take further measures to integrate social and cultural characteristics in designing policy in order to meet ESTs adoption principles. For example, building stakeholders' capacity (Zarate *et al*, 2008), increasing knowledge about the current practices and raising awareness of available treatment options (Omran *et al*, 2009).

Waste producers in the commercial sector are important partners in the SWM system structure; their attitudes and handling patterns could affect the shape of the SWM system. In Tripoli, the commercial sector is one of the main waste producers. Thus, understanding the attitudes and behaviour of commercial waste producers towards current practices is an important issue. Carrying out such a measure would help to establish a communication network as a prelude to building better solid waste management practices.

The objective of this study is to investigate commercial establishment owners' and managers' attitudes and behaviours towards current waste storage, collection and transportation practices and explore attitudes to potential new system configurations would be supported. The aim of the study is to answer the two specific research questions

- To what extent to do the existing solid waste storage, collection and transportation facilities meet commercial waste producers' requirements?
- What changes to practice would they support?

### **Environmentally Sound Technology (ESTs) as a sustainable means of MSWM**

One approach to recognising the importance of socio-technical context to MSWM is pursuing ESTs principles (Bezama *et al*, 2007). There is a significant consensus of opinion on a definition of ESTs that imply to change of socio-technical system. For example; the United Nations (UN) organisations concerned with the environment affaires have defined ESTs as a total system of technology (UNEP, 1996). They judge it is not only covers the physical equipment and layout; but it extends to include capacities to operate and carrying maintenance, as well understanding related to the application and justification; and finally the need for a network to support the effective use and management (Puustjarvi *et al*, 2003). Moreover, many scholars (e.g.; van de Klundert & Anschutz, 1999; Bezama *et al*, 2007; Najam *et al*, 2007) consider ESTs is a technology that could be adopted with a specific culture and norms in certain society, taking into consideration environmental values and aspects that have the potential to improve significantly environmental performance relative to other technologies. There are many factors that affect the adoption of EST and by which a technology can be proved to be sustainable and considered satisfactory in a certain society. These factors are said by Diaz (2010) to be specific to the given society because of their particular socio-cultural, economic and political conditions. A particular technology may be perceived within a given society as environmentally sound, while it is not so in another society.

There are two key issues; the technology itself and how it operates. Both components are required to meet the demands of the specific situation where a proposed solution is to be implemented (UNEP, 1996). However, there are many options available. How can it be

determined, for example, whether a high technology or a low technology approach would be appropriate?

In this respect, according to Macrae (2012) the design of a sustainable system always involves a number of factors. In addition to considering some constraining factors such as financial and human resources, better understanding of the culture and norms of waste producers is the most significant factor in order better to decide which is the sound option. One of main reasons for the success of MSWM systems in developed countries is the role played by the local government in extending the responsibility of service users and involving them as a main partner in MSWM (Cahill *et al*, 2011). Numerous EU countries have designed their local system based on sharing of physical and financial responsibility between the service provider and service users, whether through a municipality or not. For developing countries to attempt to replicate such approaches, local authorities need to understand the behaviour of their service users as part of their assessment procedure for technology selection.

### **Service users; close the loop to adopt ESTs**

Actors in MSWM according to many scholars, e.g. Wilson *et al* (2010) and Schübeler *et al* (1996) fall into two main categories; the government and private based institution (national and local governments; and waste service and industry organisations) and the community actors. The latter include individual service users such as residents and commercial premises (their role could be to store their waste in a proper container, separate recyclable material from other waste components and offer waste in the right place and at the proper time), or groups of waste management partners such as Non Governmental Organisations (NGOs) and Community Based Organisations (CBOs) (such organisations could carry out activities to promote re-use and recycling of material, and making arrangements with local authorities).

System participation and/or partnership may take several forms in depending on the participant and type of practice. For example; service users in different scales of industrial and commercial establishments and institutions have similar interests in a reliable and affordable waste collection service. Commercial establishments are particularly concerned to avoid waste related pollution, which would inconvenience their customers. Therefore, they could play effective role in waste collection and transportation. While industrial enterprises may have a strong interest in reducing waste generation and how to treat. Then, they can play an active role in promoting cleaner technology or in treatment facilities. Therefore, Godfrey (2008) and Godfrey & Scott (2010) recommend that whatever technology is to be adopted in any solid waste practices in a certain society, the individual or target group should be informed and given the necessary information to make them aware and able to play their role toward technology setting. Nevertheless, despite the importance of waste users as a partner in reform of the MSWM system towards sustainability, (Ahmed and Ali (2006) and Ali (2010) observed that in many developing countries the relationship between the service providers and service users is weak. Furthermore, national and local governments believe that it is not necessary for the service users to be one of the actors in solid waste service provision. In this sense, there are many cases of waste management practices that did not meet the service user perspective (Koushki *et al*, 2004), because the service users thought they did not have a role in such practices, so they were beyond the scope of their responsibility. In the past, the problem in developing countries was reflected

in the lack of capacity to establish relationship between public and private sector. Nowadays to a certain degree many of these countries have succeeded to fulfil such a task (Kassim & Ali, 2006). However, setting up of partnership with a third tier of people to build new structures is still demand and many countries seeking to achieved. Therefore, may what is challenging developing countries currently is to find a common platform for discussion to attract the third party (the community) to be included within public-private partnership, in order to shift in people's role, from passive service receivers to active service partners.

### **Handling of Commercial waste**

Commercial waste is that waste which results from a business and its operations. This study is concerned only with the commercial sector. This means those who are running formal trading and services activities, including of different sizes of supermarkets and shops, coffee shops, hotels and restaurants.

Commercial waste to large extent is similar in composition to household waste. For example in many cases they include cardboard, paper and plastic. However, many developed countries combine the commercial waste with industrial waste and build their strategy accordingly as one waste generation sector (Mcleod et al, 2011). As regards legislation, the generators of such waste have duty to collect and/or to manage what is produced under their responsibility. On the contrary, in many developing countries, such practices is not adopted (Antipolis, 2000; Coffey & Coad, 2010). The waste generated from commercial activities is often managed in one stream with household solid waste under the municipality jurisdiction. In Egypt, as example, the solid waste generated from both the commercial sector ranks in the second place of about 15% after residential waste (64%) (Badran & El-Haggar, 2006). Collection of commercial waste in Egypt, like in other developing countries, is in one stream with household waste. The responsibility for managing such waste lies with the municipalities at local level.

Commercial sector waste users represent an important body in solid waste generation. Thus, it seems necessary to set strategic plans related to their waste generation. In this sense, attention is paid in developed countries to managing waste generated by this sector. For example; within the EU policy, measures have been taken regarding packaging and packaging waste in Directive 94/62/EC, which aims to limit the production of packaging waste and promote of recycling technologies and recovery activities. Based on this approach, each EU member state is committed to implement sound technologies to meet EU policy. The United Kingdom as one of these countries seeks to reduce the amount of waste generated by this sector, which accounts for a higher percentage than household waste (annual generation of commercial waste is 30 million tonnes/year compared to 25 million tonnes/year for household), and to design suitable technologies for treatment to reduce the amount sent to landfill (Mcleod *et al*, 2011). In this context, the developing countries could learn from the lessons of advanced countries under condition of respect for differences of cultural, socioeconomic and political conditions between countries.

### **Method**

In this study, quantitative research was conducted in the end of 2011, in the capital city of Libya, Tripoli, as a case study. A self-administered questionnaire was designed to assess the commercial owners' and managers' attitudes and behaviours towards current solid waste

practices and their views on overall MSWM in the city, as well as changes in the practices they would like to be supported. Tripoli city was selected for a variety of reasons, the most significant being;

- Tripoli is a centre for economic and services activities, which are a source of waste generation. Therefore a variety of commercial activities are expected to exist which would use different MSWM technologies.
- MSWM service in the city is offered by both public and private sector providers, so there is a potential for different views.
- The researcher is familiar with the city in terms of SWM as he was a member staff of EGA in Solid Waste Management Department in Tripoli for more than 15 years.

The city of Tripoli is administratively divided into 23 districts. Each of them has its commercial activities. The municipality has benefited from this structure and it has designed five residential zones for management of solid waste that has been produced either by from residents of these zones or from any operating activities. The solid waste service providers in these zones vary. In some zones the public company is the main service provider, whereas in other zones private companies dominate. Therefore, based on these geographical characteristics of the city, the questionnaires were distributed to commercial owners and managers from the five residential zones in the city. The sample was selected randomly by the principle of award of licenses at five municipal districts. The distribution of the questionnaires differed significantly with respect to density and type of commercial activities (Cochran, 1977). A total of 186 completed questionnaires were returned giving a response rate of 84%.

A binary scale was employed to construct the survey questionnaire. The respondents were asked to indicate their views on whether each item was met with a 'yes' or 'no' answer. Adopting the binary answer format has many advantages. Every issue comprises a set of items, to which the responses may be a mixture of positive and negative replies. Therefore, the positive or negative attitude overall is determined by comparing the number of positive and negative replies in each section to the mean number. Methodologically; according to Dolnicar (2003) applying the binary scale has advantages over other scales as the respondents cannot possibly exaggerate their answers. Practically it is a simple way of assessing public opinion; as it is easy to answer the given questions, even when the subjects of the study have a low level of knowledge.

Personal distribution was chosen for administering the questionnaire to each residential zone. The respondents were given a period of time to answer before the questionnaires were collected. Applying this approach ensured that the questionnaires were distributed correctly to the sample and helped to maximise the number collected. The gathered data was analysed using the Statistical Package for Social Science (SPSS version 19) software.

### **Waste management of Commercial sector in Tripoli city**

According to the African Economic Outlook report for year 2011, the commercial sector, consisting of wholesale and retail trade, hotels and restaurants, in Libya has increased its contribution in GDP from 4 % in 2005 to 4.9 % in 2011 (AEO, 2011). There were two significant factors behind the growth of commercial sector that contributed to emergence of new related activities in the city. Firstly, the geographical location of the Tripoli city as a



centre of economic and services activities (Elbendak, 2008). Secondly, high unemployment rate and low wages in the state sector have contributed to an increasing move towards privatization through running business and services activities (Otman & Karlberg, 2007). However, in the city, the generation of solid waste by the commercial sector according to a study carried out by Environmental General authority (EGA) jointly with the United Nations Development Programme (UNDP) in 2010 is considered as the second major waste producer after the residential sector (EGA/UNDP, 2010). The study revealed that the main types of waste generated are cartons, plastic bags, and plastic water bottles. Figure 1, illustrates that the 58.62% of the waste generated by commercial establishments is recyclable, while mixed waste comprises 24.13 % and organic waste only 17.25 %. Dry waste forms the major part of commercial waste. Thus, in Tripoli there it could be an opportunity to create recycling practices if they meet the activities' requirements.

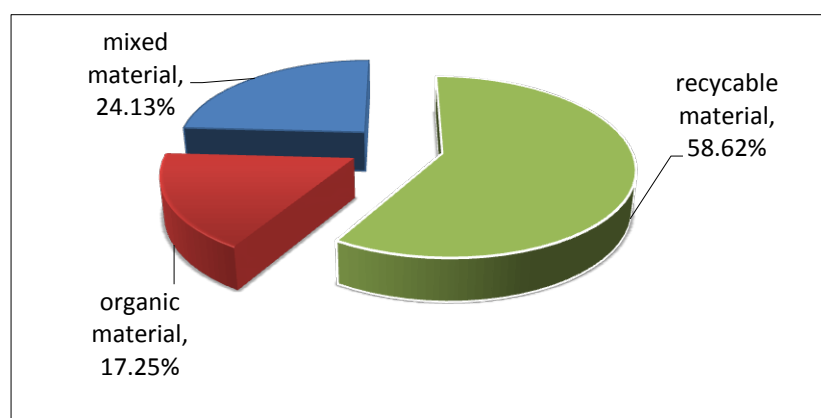


Figure 1; Percentage composition of commercial waste in Tripoli  
Source; (EGA/UNDP, 2010)

Waste management for the commercial sector in the city is served either by the Tripoli Public Service Company (TPSC) or by one of the private sector companies operating in the city (PCTCs) which are a group of fifty three companies. However, many of large shops hire a service for disposal of waste by informal contract with companies rather than those working with the municipality (PCTCs) (EGA/UNDP, 2010).

The national government in 1994 issued a decree setting out the tariffs for provision of solid waste service for commercial establishments. Table 1 displays the nature of commercial activities together with maximum and minimum limits for the fees by Libyan Dinar (LD) to be collected by waste service producers. However, in developing countries the problem often remains as how to implement what the government has determined as policies (Deutz & Frostick, 2009).

Table 1 Waste collection fees bands for each commercial activity

Type of activity	Fees category LD/annually
Hotels	400-2000
Restaurants and snack shops	300-1000
Cafes	250-500
Theatres, cinemas	650-1000

Other shops subject to the provisions of the licences list	15-1200
Marketing of agricultural production of public markets	5 LD/day
Source Ministry of Housing and Public utility document (MUPU, 1996)	

## Result and discussion

### 1. Storage practices

- *Current practices*

To discover what the existing waste storage practices are, the respondents were asked to describe their storage container, if they have one. Table 2 illustrates aspects that influenced the views. Firstly it displays whether the owners/managers of commercial premises have a container or not, and if they have, in which type of container they store their waste until the operational body (TPSC or PCTCs) collects it.

Table 2 Solid waste storage facilities and its percentage of usage

	Percent
No storage facilities	35.1
Bin (plastic or metal)	29.7
Plastic bag	22.7
Other	12.5
Total	100.0

The result in Table 2 indicates that there is a quite number of commercial premises did not have container to store their solid waste. However, who have a container usually used either wheeled bin or plastic bag. There are a variety of requirements that determine whether storage container is satisfied with the type of waste to be stored, such as size, shape and durability (Martin, 2011). From the results in Table 2, it seems the wheeled bin is the most convenient storage container for commercial waste. Employ of such a container imply that this group of commercial premises could have well infrastructure and may receive satisfactory service.

- *Respondents attitude*

The attitude of respondents towards the storage facilities was measured based on the mean score (Table 3). The attitudes scale is divided into two points of view; positive and negative. Thus, items with a mean number higher than 1.49 were seen as reflecting a positive attitude, while those with a value lower than the mean number were seen as reflecting negative attitude.

Table 3 Attitude towards storage facilities

	Percent
Positive	60.5
Negative	39.5
Total	100.0

A significant percentage of owners/managers of commercial premises (60.5%) had a positive attitude towards storage facilities that were positioned by TPSC and/or PCTCs. The attitude is positive despite the current practices that carried out by TPSC and/or PCTCs are not rise to the concept of sustainability (Gebril *et al*, 2010).

- *Responsibility towards current practices*

In terms of responsibilities; it seems that the service users are undertaking their duties, although there is no storage container in one third (35.1%; Table 2) of the commercial premises surveyed. However, failure of service provider companies to provide storage containers did not influence the owners/managers' positive attitude. Table 4 examine the degree of association between kind of storage container that used and how is deliver this container. The result shows that the willingness of the owners/managers of commercial establishment to obtain a storage container is not affected by who was delivered this container. This represents that the owners/managers of commercial establishment has taken part in storage practice when he/she bought his/her containers whatever is it. This indicates that the owners/managers of commercial establishment are preference to have a storage container even if purchased by himself/herself. Therefore, it is observed that the action by the owners/managers of commercial establishment to cover the shortcoming in operational companies was evident; 56.9% of the respondents had bought their own waste storage container.

Table 4; Relationship between type of storage container and who is delivered

What Type of storage container do you have?	Who is delivered to you?		Total
	Count (% row, % column)		Count (% row, % column)
	My self	By service provider	
Bin (plastic or metal)	22 (44.0%, 35.5%)	28 (56.0%, 59.6%)	50 (100.0%, 45.9%)
Plastic page	28 (73.7%, 45.2%)	10 (26.3%, 21.3%)	38 (100.0%, 34.9%)
Other	12 (57.1%, 19.4%)	9 (42.9%, 19.1%)	21 (100.0%, 19.3%)
Total	62 (56.9%, 100.0%)	47 (43.1%, 100.0%)	109 (100.0%, 100.0%)
$\chi^2$	Value 3.323	df 2	Significance 0.190

## 2. Collection practices

- *Current practices*

In general, to achieve sustainability for whatever the system is designed for, the collection system must be designed and operated in an integrated way. For example; the method of loading a collection truck must suit the mode of storing waste. If the waste is destined for recycling, then it should be designed to ensure minimum contamination. In this study, the collection practices that carried out in Tripoli city were investigated. Table 5 shows aspects of current practices undertaking by service providers to collect waste from the commercial premises.

Table 5 Faults in the current solid waste collection practices

	Percent
No collection practices	22.8
Insufficient equipment	29.4
Time of collection is unsuitable	24.2
Collection staff	16.4
Other	7.2
Total	100.0

Even though 22.8% of the commercial establishments were not covered by waste collection service, the major concerns of the respondents were insufficient equipment and unsuitable time of collection. The results showed that 29.4% of the respondents perceive of that the lack of collection equipment allocated for them was the main issue, and 24.2% believed that the time of waste collection was the main aspect. Carrying out of waste collection practices is relatively closed to who is the waste generator. Hence, adoption of sound collection practices requires basic principles of use of adequate and appropriate technology, determining the most suitable time to carry out waste collection based on type of service users and training of collection staff on the used collection method (Coffey & Coad, 2010; Gallardo *et al.*, 2010; Dostal, 2004).

- *Respondents attitude*

The attitude of respondents towards the collection practices was investigated. The classification was also made based on the mean number, which was 1.64. Therefore, items scoring higher than the mean number were measured as reflecting a positive attitude, whilst those with values lower than the mean number were seen as reflecting negative attitude (Table 6). The attitudes of owners/managers of commercial establishment concerning collection and practices appear different. The result indicates that over half of the respondents (54.1%) had negative attitudes towards practices of collection practices.

Table 6 Attitude towards collection practices

	Percent
Positive	45.9
Negative	54.1
Total	100.0

The effectiveness of collection practices is determined by who is collect and how the waste is collected. In Libya, where the responsibility of collection the commercial waste is lies to the municipalities. Therefore, the policy towards involving the private sector is limited and focuses on the public sector to acquisition. As consequences, there is no effective system to manage solid waste. For example; some of the municipal waste is uncollected (Abdelnaser *et al*, 2011). Adopting a common collection system for householders and commercial waste affects both waste producers, as they are served by same service provider. Accordingly, it is expected to have shortcoming in collection practices in commercial waste equal to what is observed in household waste.

- *Transportation practices*

- *Current practices*

The respondents were asked to describe current transportation practices to know what is available. Table 7 shows the types of vehicles employed to carry commercial solid waste in the city.

Table 7 Transportation of solid waste facilities and its percentage of usage

	Percent
No transportation facility	0
Compactor truck	36.5
Open truck	47.3
Tractor	2.7
Handcart	12.2
Other	1.3
Total	100.0

Despite the availability of vehicles and other facilities to transfer the waste from collection points to the second destination, there was disappointment with the current transportation practices. As shown in the Table 7; around one-third of the respondents said that their waste was transferred by compactor trucks, while half of them they said the service providers used open trucks and tractors to load the waste they generated. This result reveals that there needs to be considerable attention to the selection of vehicles to be appropriate for any particular situation. In this case therefore, service providers should follow the comments of Coffey & Coad (2010; 58-95) in the selection of waste collection vehicles.

- *Respondents attitude*

In this part, the positive and negative attitude towards transportation practices was also measured based on the mean number. As shown in Table 8, the percentage of positive attitude means that those items have higher than the mean number of 1.54, while the percentage of positive attitude means that those items have lower than the mean number of 1.54.

Table 8 Attitude towards transportation practices

	Percent
Positive	48.7
Negative	51.3
Total	100.0

Once again negative attitude is expressed towards transportation practices in the city. The result in Table 8 shows that over half of the respondents (51.3%) had negative attitudes towards waste transportation practices. The findings reflect that there is an urgent need to improve collection and transportation practices, especially as Waste collection and transportation practices are considered as an integral part of integrated and sustainable MSWM (Alam *et al*, 2008).

Collect of the commercial waste with the household waste in one stream that means using of the same vehicles to transport to the next destination. Technically, apply of such a method is affects the efficiency of the system even if they storing the waste in separate containers because the wastes in the end will mix together. Selection of appropriate vehicles is very important issue for sustainability of the system. Attract service user's attention that the vehicles were selected according to the type of the waste they produced is important to receive their support (Martin, 2011).

- *Responsibility towards current collection and transportation practices*

The responsibility of service user towards the collection and transportation practices was examined in terms of willingness to pay for providing the service according to fees allocated by the national government (Table 1). It seems that the waste service that offered to the traders is affected their responsibility of willingness to pay. This result as in Table 9 shows a strong statistically significant relationship between type waste collection and transportation practices provided and willingness of the traders to pay-for-service. This refers to whenever the times of collection was decreased, the more traders refused to make a payment. This indicates that traders are demanding for better collection and transportation service to become an active partner.

Table 9; Relationship between availability of waste regular collection and transportation services with willingness to pay

Do you have a regular waste service?	Are you pay for waste service?		Total
	Count (% row, % column)		Count (% row, % column)
	Yes	No	
Yes	42 (56.0%, 58.3%)	33 (44.0%, 34.4%)	75 (100.0%, 44.6%)
No	30 (32.3%, 41.7%)	63 (67.7%, 65.6%)	93 (100.0%, 55.4%)
Total	72 (42.9%, 100.0%)	96 (57.1%, 100.0%)	168 (100.0%, 100.0%)
	Value	df	Significance
$\chi^2$	9.556	1	0.002

### 3. *Attitude to create sound practices*

The level of support of respondents towards changes the current practices was determined. Again, the classification was based on the mean number. As apparent in Table 10, who would support is was linked with those items that have a number higher than the mean of 1.58, and how reject to make contribution ascribed to those with value lower than the mean number of 1.58.

Table 10 Support attitudes towards changes of current MSWIM practices

	Percent
Yes	51.4
No	48.6
Total	100.0

After the negative attitudes towards collection and transportation practices that have been expressed by owners/managers of commercial establishments, they expressed their support for change to some of these unsound practices. Above half (51.4%) of the respondents showed their willingness to cooperate if there is an intention to change unsound current practices. Though the percentage is not much high, but it is a positive sign indicating that they are desire to support. The result suggests that the commercial sector in Tripoli is willing to change practices that had bothered them. This means many things, including the service users may are conscious and they aware of the service providers practices and they would like to contribute to raise the level of the service to achieve their interests, whether it is environmental or any other the objective.

The solid waste practices that were proposed to be supported are explored. Table 11 displays the aspects of the current practices that the owners/managers of commercial establishments want to be changed and are prepared to support.

Table 11 Support level towards change of current practices

Attitude to support	Percent
Storage separation	21.2
More frequent collection practice	12.1
Use of mechanical facility	11.6
Increase number of equipment	39.4
Increase number of workers	6.3
Increase of recycling activity	7.1
Other	2.3
Total	100.0

The result of the study showed that the most two important changes they would like to see are increase of number of equipment (39.4%) and waste storage in a separate bin (21.2%). More frequent collection practice and use of mechanical facilities were the second priority in for support. While increase of recycling activities and increase in the number of workers were accorded the lowest priority. These findings support what is advocated by Schübeler *et al* (1996) and Gallardo *et al* (2010) that the building of a sustainable system for the solid waste sector is affected by the extent to which service users can play their role and assume their responsibility. Therefore, to transfer from attitude to behaviour as partners it is recommended that commercial enterprise owners and managers are motivated and encouraged through raising their awareness and improving their knowledge.

## Conclusion

In order to build an integrated and sustainable MSWM, first of all requires success in establishing an effective collection system. In this context, Libya, like many developing countries still faces dilemmas in building a sustainable waste collection and transportation system. Whilst the study showed that there is positive attitude has been approved by owners/managers of commercial establishments towards storage practices, the practices implemented in collection and transportation activities did not meet their needs. The TPSC and/ or PCTCs used insufficient equipment or in many cases there is no equipment at all, collection of waste occurs at irregular and inappropriate times and staff is incompetent.

These factors led to the emergence of practices that did not satisfy service users. Consequently, it is essential for the service providers in the Tripoli city to carry out additional work to reform current practices if they intend to promote ESTs in this field. Perhaps initially take the necessary steps to address the common collection stream from different waste generators and setting a separate collection systems, especially for commercial waste as it represents large quantity and it is source of a raw material for recycling industry. Thus, what is challenging the policy-makers in Tripoli city is who to regulate the waste management produced from the commercial sector. Increase private sector participation and giving more authority to collect commercial waste in separate stream may undermine the dominant of the public sector. In this sense, experience of developed countries could be employed for to reform the system.

As Coffey & coad (2010) argued; If we wanted to explore who is responsible for carrying out MSWM activities, we knew that the responsibility for carrying out collection and transportation practices to a large extent lies with service providers. Whereas in storage practices, the responsibility of service users is growing (Schübeler *et al*, 1996). Accordingly, the policy should be formulated based upon. Participation of waste users in adopting technology through exchange of opinions and engagement in waste management activities is an important issue to attain the concept of sustainability. To improve the attitude of service users towards the service provided, the MSWM authorities at different levels in Tripoli city should think about new forms of management structure. Once that is agreed, responsibilities should be shared by the local authority (including service providers) and service users, to give stakeholders in the commercial sector better access and to allow them to play their role in the city in terms of MSWM. In this context, the duties of local government including service providers are numerous: awareness-raising, providing information and promoting better understanding of their value of participation in such SWM activities, and thus ensuring that commercial sector actors will be partners in all aspects of the management process.

In Tripoli city there is an opportunity to reform the unacceptable MSWM for the commercial sector. According to the results obtained from the study, the level of support from owners/managers of commercial establishments for changes in the current system is relatively high. It's exhilarating that the traders in the city are willing to contribute. In the past, they play their role in storage practice, for example, over half of the respondents bought their bin by themselves. This index indicates that they are serious to provide support to local authority. Carrying out more studies for better understand of positive behaviour is recommended. Therefore, the ball is in the court of regulatory body. It is the role of local authority to cooperate with this group of society, to implement sound practices. Such an initiative to change the current system should be built on those aspect indicated as attracting support.



## Reference

- Abdelnaser, O., Alsadey, S., Gavrilesco, M. (2011). Municipal solid waste management in Bani Walid city, Libya: Practices and challenges. *Environmental Management and Tourism*, 2(2), 228-337.
- AEO. (2011). The African Economic Outlook 2011; Africa and its Emerging Partners. Retrieved April 17, 2012, from [http://www.africaneconomicoutlook.org/fileadmin/uploads/aeo/Country\\_Notes/2011/Full/Libya.pdf](http://www.africaneconomicoutlook.org/fileadmin/uploads/aeo/Country_Notes/2011/Full/Libya.pdf)
- Ahmed, A., Ali, M. (2006). People as partners: Facilitating people's participation in public-private partnerships for solid waste management. *Habitat International*, 30(4), 781-796.
- Alam, R., Chowdhury, M., Hasan, J., Karanjit, B., Shrestha, R. (2008). Generation, storage, collection and transportation of municipal solid waste--a case study in the city of Kathmandu, capital of Nepal. *Waste management*, 28(6), 1088-97.
- Ali, A. (2010). Wasting time on solid waste in developing countries. *Waste management*, 30(8-9), 1437-8.
- Antipolis, S. (2000). Policy and Institutional Assessment of Solid Waste Management in Five Countries: Cyprus, Egypt, Lebanon, Syria and Tunisia. Valbonne.
- Aziz, A. (2009). Investigating households' attitude toward recycling of Solid Waste in Malaysia: A Case Study. *Int. J. Environ. Res.*, 3(2), 275-288.
- Badran, F., El-Hagggar, M. (2006). Optimization of municipal solid waste management in Port Said - Egypt. *Waste management*, 26(5), 534-45.
- Bernstein, J. (2004). Toolkit for Social Assessment and Public Participation in Municipal Solid Waste Management. Washington. World Bank.

- Bezama, a., Szarka, N., Navia, R., Konrad, O., Lorber, E. (2007). Lessons learned for a more efficient knowledge and technology transfer to South American countries in the fields of solid waste and contaminated sites management. *Waste Management & Research*, 25(2), 148-161.
- Bhuiyan, H. (2010). A crisis in governance: Urban solid waste management in Bangladesh. *Habitat International*, 34(1), 125-133.
- Cahill, R., Grimes, M., Wilson, C. (2011). Extended producer responsibility for packaging wastes and WEEE - a comparison of implementation and the role of local authorities across Europe. *Waste management & research*, 29(5), 455-79.
- Cochran, G. (1977). Sampling techniques. (Wiley, Ed.) (3rd ed.).
- Coffey, M. Coad, A. (2010). Collection of Municipal Solid Waste in Developing Countries. (UN-Habitat, Ed.) (2nd edn.). Nairobi, Kenya.
- Deutz, P., Frostick, E. (2009). Reconciling policy, practice, and theorisations of waste management. *Geographical Journal*, 175(4), 247-250.
- Diaz, F. (2010). Low versus high-technology. *Waste Management*, 30(3), 367-368.
- Dolnicar, S. (2003). Simplifying three-way questionnaires—Do the advantages of binary answer categories compensate for the loss of information? *CD Proceeding*. Adelaide, Australia: Australia and New Zealand Marketing Academy (ANZMAC).
- Dostal, G. (2004). Overview of Household Collection Systems in Different Cities and Regions. *ISWA*. Vienna, Austria.
- EGA/UNDP. (2010). Municipal Solid Waste Report 2010, Solid waste management project edn,. Tripoli, Libya.
- Elbendak, O. (2008). Urban Transformation and Social Change in a Libyan City: An Anthropological Study of Tripoli. National University of Ireland, Maynooth.
- Faras, B. Alqrau, Z., (2004). Municipal solid waste management in Libyan cities. Background paper for recent trends in waste management. Third Arab Conference for Environmental Management, Egypt

- Gebril, O., Abdelnaser, O., Pakir, K., Aziz, A. (2010). Municipal solid waste management in Benghazi (Libya): Current practices and challenges. *Environmental Engineering and Management*, 9(9), 1289-1296.
- Godfrey, L. (2008). Facilitating the improved management of waste in South Africa through a national waste information system. *Waste management*, 28(9), 1660-71.
- Godfrey, L., Scott, D. (2011). Improving waste management through a process of learning: the South African waste information system. *Waste management & research*, 29(5), 501-11.
- Kassim, M., Ali, M. (2006). Solid waste collection by the private sector: Households' perspective—Findings from a study in Dar es Salaam city, Tanzania. *Habitat International*, 30(4), 769-780.
- Koushki, A., Alhumoud, M., Al-duaij, U. (2004). Municipal solid waste in Kuwait: Trends and attitudes on collection, separation and willingness to pay, 1(2), 173-188.
- Macrae, G. (2012). Solid waste management in tropical Asia: what can we learn from Bali? *Waste management & research*, 30(1), 72-9.
- Mcleod, N., Cherrett, J. Waterson, J. (2011). The scope for joint household / commercial waste collections: a case study. *International Journal of Logistics Research and Applications*, 14(6), 37-41.
- Martin, O. (2011). Governance crisis or attitudinal challenges? Generation, Collection, Storage and Transportation of Solid Waste in Ghana. *Integrated Waste Management* (1st ed., Vol. 1).
- MHPU, Ministry of Housing and Public Utility. Financial Decree No 30 for year 1996.
- Najam, A. and Karlberg, E. (2007). Trade and Environment: *A Resource Book*. International Institute for Sustainable Development. Geneva.
- Obeng, P. A., Donkor, E. a., & Mensah, A. (2009). Assessment of institutional structures for solid waste management in Kumasi. *Management of Environmental Quality: An International Journal*, 20(2), 106-120.

- Otman, W. Karlberg, E. (2007). *The Libyan Economy*. (Springer, Ed.). Berlin Heidelberg New York.
- Pires, A., Martinho, G., Chang, B. (2011). Solid waste management in European countries: a review of systems analysis techniques. *Journal of environmental management*, 92(4), 1033-50.
- Puustjarvi Esa, K. and S. (2003). Transfer of environmentally sound technologies from developed countries to developing countries. *Background Document for the Ad Hoc Expert Group on Finance and Environmentally Sound Technologies*. Helsinki.
- Schübeler, P. Wehrle, K. Christen, J. (1996). Conceptual Framework for Municipal Solid Waste Management in Low-income Countries. Swiss Centre for Development Cooperation in Technology and Management, Gallen, Switzerland.
- Timlett, R. Williams, I., (2008) Public participation and recycling performance in England: A comparison of tools for behaviour change. *Resources, Conservation and Recycling*; 52(4), 622–634
- Troschinetz, A. Mihelcic, J., (2009). Sustainable recycling of municipal solid waste in developing countries. *Waste Management*, 29(2), 915–923
- UNEP, (1996). International source book on environmentally sound technologies for municipal solid waste management. Shiga, Japan: . International Environmental Technology Centre, UNEP.
- van de Klundert, A. Anschutz, J. (1999). Integrated Sustainable Waste Management: the selection of appropriate technologies and the design of sustainable systems is not (only) a technical issue. In P. prepared for the C. I.-R. W. on T. for S. W. Management (Ed.), . Alexandria, Egypt
- Wilson, D. C., Rodic, L., Scheinberg, A., Velis, C. a, & Alabaster, G. (2012). Comparative analysis of solid waste management in 20 cities. *Waste management & research*, 30(3), 237-54.
- Wilson, D. Scheinberg, A. Wiersma, L. (2010). Solid Waste Management in the World's Cities. (UN-HABITAT., Ed.). Earthscan.

Zarate, a, Slotnick, J., Ramos, M. (2008). Capacity building in rural Guatemala by implementing a solid waste management program. *Waste management*, 28(12), 2542-51.

Zurbrügg, C. (2003). Solid Waste Management in Developing Countries: Solid waste management includes all activities that seek to minimise the health, environmental and aesthetic impacts of solid wastes. *Eawag/Sandec*.

# **The Effectiveness and Feasibility Analysis of Low Impact Development Stormwater Management on Xiamen Island**

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## **Introduction**

Urbanization is one of the results as the modern social development. As more and more people live in cities, more buildings are constructed. Therefore, impervious surface area increases which resulted in increasing surface runoff, decreasing groundwater recharge and base flow, and other environmental impacts (Dietz, 2007; Tang et al., 2005). Water resource protection at the local level is getting more complicated, largely due to the recognition of non-point source pollution, or polluted runoff, as a major problem. This diffuse form of pollution is derived from contaminants washed off the surface of the land by stormwater runoff, and carried either directly or indirectly into waterways or groundwater. Stormwater runoff will bring more problems as the increase of impervious surface area. In order to control stormwater runoff, many techniques have been applied. Low Impact Development (LID) is one of them. As the definition from the Unified Facilities Criteria, America (UFC, 2004):

Low Impact Development is a stormwater management strategy concerned with maintaining or restoring the natural hydrologic functions of a site to achieve

natural resource protection objectives and fulfill environmental regulatory requirements.

A series of natural and artificial technologies are applied to infiltrate rain water, filter pollution, and reduce as much the impacts of stormwater on environment as possible.

LID provides not only environmentally sustainable tools but also new economically methods for local officials, the private sector and others to better address non-point pollution wet weather flow regulatory challenges for the protection of our receiving waters. Instead of the large investments in complex and costly centralized conveyance and treatment infrastructure, LID allows for the integration of treatment and management measures into urban site features. LID encourages the multifunctional cost-effective use of the urban green space, buildings, landscaping, parking lots, roadways, sidewalks, and various other techniques to detain, filter, treat and reduce runoff. LID is completely different from conventional management strategies.

Through LID's new advance technological tools it is possible to have better environmental protection for significantly less cost. The LID idea has been developed to many other ideas like LIUDD in New Zealand, WSUD in Australia, the SUDs in UK, etc.

Xiamen Island faces problems of the shortage of water and the pollution including surface runoff drainage to the sea associated with the rapid urbanization. Therefore, it is necessary to find out sustainable stormwater management which can effectively apply to the city development. In this study, a porous parking lot and an extensive green roof in the campus of Xiamen University has been selected as the study area and their effectiveness were tested.

## Case study

In this study, both of the two study areas located in the campus of Xiamen University. The porous parking lot was built on 2003 and has been used under high frequency since then. The green roof was built on 2004 and 2007 separately with different cover type. Six rain events were observed from January to May on 2008, and runoff samples were taken on both sites during the rain events and tested within 24 hours. The results show that both of these technologies can improve the local environment quality.

First, flood control ability. The LID practices can be relative effective in controlling peak discharge rates. Under the condition that the rainfall intensity  $<3.88 \text{ mm}\cdot\text{h}^{-1}$ , when the direct runoff appears on the grasspave pervious parking lot area, the time can delay up to 30 minutes relative to the impervious area. In general, as the study examined, the rainfall intensity will result a noticeable gain in precipitation retention. The infiltrations in the grasspave pervious area are hardly measurable, and greatly delay up to the time when the runoff appeared in the impervious and pervious area. Hydrologic improvements are smallest for large events and high antecedent water contents. The green roof can delay up to 200 minutes under the same condition. Even when the infiltration appeared, the flow rates of infiltration are very slowly. There no measurable runoff on the surface of the soil. This means the green roof have a high performance in infiltration and can retention a lot rainfall. The retention ability of green roof decrease as well as the rainfall intensity increase. When the rainfall intensity  $\leq 1.5 \text{ mm}\cdot\text{h}^{-1}$  the green roof has 100% retention of precipitation.

Second, pollution prevention and removal ability. The LID practices can effectively reduce and remove the pollutants from the runoff. The pH of runoff can be maintained between 7.5-8.0 after the pretreatment of the grasspave parking lot; the retention of total suspended solids only be 13.86%; Nitrogen behavior is complex because of the biogeochemical complexity of the nitrogen species. Ammonia capture is somewhat variable, with 39% removal,  $\text{NO}_3\text{-N}$  removal was good, at 76.55%; high concentration reductions ( $>60\%$ ) were found for zinc (Zn), copper (Cu) and lead (Pb); the



concentration of pollution in the infiltration are higher than the runoff. In general, this grasspave parking lot has good pollution control ability. The water quality of runoff from green roof is very good and can hardly influence the environment.

Third, using LID practices are feasible on Xiamen island. In terms of costs, LID techniques can reduce the amount of materials needed for paving roads and driveways and for installing curbs and gutters. But the use of LID techniques might not always result in lower projects costs. The costs might be higher because of the costs of plant material, site preparation, soil amendments, underdrains and connections to municipal stormwater systems, and increased project management. But the benefit of using LID techniques can be: reductions in pollutants, protection of downstream water resources, ground water recharge, reductions in pollutant treatment costs, reductions in the frequency and severity of CSOs, and habitat improvements, increases in real estate value, increased parcel lot yield, increased aesthetic value, and improvement of quality of life by providing open space for recreation. The environment condition of Xiamen Island is suitable for using the LID stormwater management strategies.

## **Conclusion**

Both of the two LID technologies can improve the local flood control and pollution prevention and reduction which pledge the prospect of its application in China. However, some problems may restrict the performance of them. First, the unqualified construction may decrease the technologies' effectiveness. Some parts of the construction do not meet the standards which is a common phenomenon in China. Second, routine maintenance is needed, such as soil amendment, preventing clogging, replacing vegetation after a long using, et al. Maintenance will ensure the facilities work well. Third, the limitation of the study areas and the study time period may not fully show the performance of these two technologies. It will be better to improve it and include the other LID technologies in the future study, so that the effectiveness and application of LID strategy in China can be fully explored. Finally, the cost of some facilities construction and maintenance are more expensive than the

conventional one which may constraint the development of these sustainable technologies. Fortunately, the China's government has made some policies that may greatly promote the development of them in the future.

## References

- Dietz, M.E. (2007) Low impact development practices: a review of current researches and recommendations for future direction. *Water air soil pollut*, 186: 351-363.
- Tang, Z., Engel, B.A., Pijanowski, B.C., Lim, K.J. (2005) Forecasting land use change and its environmental impact at a watershed scale. *Journal of environmental management*, 76(1): 35-45.
- Unified Facilities Criteria (UFC). 25/10/2004 *Design: low impact development manual*  
[http://www.lowimpactdevelopment.org/lid%20articles/ufc\\_3\\_210\\_10.pdf](http://www.lowimpactdevelopment.org/lid%20articles/ufc_3_210_10.pdf) viewed 14/03/2011 viewed 13/03/2008.

# **Proceedings of the 18<sup>th</sup> Annual International Sustainable Development Research Conference, University of Hull, Hull, UK, 24 – 26 June 2012; Track 5d**

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Track 5d: Planning for sustainable management of water/energy/waste and ecological resources  
Preferred form of presentation: oral

## **Title:**

### **A concept to achieve energy autarky in Austria: Indicators, Dynamics, Potential**

The shortage of non-renewable resources has been the main focus of concern within the last decades. Especially the “oil crisis” in the 1970’s demonstrated the relevance of a sustainable usage of non-renewable energy sources such as oil, coal or gas. The current dependence of fossil fuels leads to economic and political uncertainties such as increasing energy prices and causes a steady and irreversible climate change due to permanently increasing CO<sub>2</sub> emissions.

Ultimately, all non-renewable resources on Earth are limited: if used constantly they must sooner or later run out. To act in a sustainable manner, we have to find a solution to satisfy the needs of the present, without compromising the ability of future generations to meet their own needs.

Despite these facts, global energy production is still highly depended on mainly fossil fuel based energy sources. Furthermore, the steady rise in population and the economic growth lead to an increasing consumption of energy and doesn’t make it easier to initiate the turnaround.

Although Austria has a high potential of natural energy sources such as water or wood and Austrian government aims for the reinforced usage of these renewable energies, the dependency on fossil fuels and also the emissions of greenhouse gases are rising constantly. As many other European countries, Austria faces the challenge to find a pathway away from existing centralized and mainly fossil fuel based energy sources towards more decentralized energy production systems based on domestic renewable energy sources. In addition to the intensified exertion of renewable energy sources, decentralized production of it will play an important role to ensure a sustainable energy management for Austria in the future. Initiatives to force on-site renewable energy production based on a local and regional scale are a good chance to achieve energy autarky in Austria at the long run.

For the purpose of this research work, the term “decentralized energy production” or “on-site energy” will be used to mean production and distribution of energy within the boundaries of, or located nearby and directly connected to, a building, community or development. It may apply to heat or electricity. On-site energy systems may be connected to external energy networks, especially the electricity grid, from which they may both import and export energy.

Energy autarky in this context means, that Austria will be at 100% supplied from domestic sources of renewable energy. It is also assumed that the present net energy import of gray energy in commodities will not further increase. At the moment Austria imports by far more energy in the form of grey energy in commodities than it exports in that same way. If this net balance with foreign

countries via “energy in commodities” were taken into account, Austria’s consumption of fossil energy would presently be 44% higher than the figures in the energy statistics imply. This is of relevance also for the interpretation of the term “energy autarky” and for the scenario developed in this study. Only agricultural surplus land is used to cover the energy demand by means of renewable energy sources. Austria’s demand for agricultural land dedicated to the food and feedstock production remains the same. Energy exchange with the neighbouring EU countries is permitted in imports/exports on a daily/weekly basis – on annual average the import/export balance is zero. As regards electricity storage, it is assumed that all Austria has to do is to intermediately store its electricity overproduction in summer in its own pumped storage power stations or chemical storage systems. The role which smart grids may play in the future to interconnect (decentralized) producers, storage systems and consumers is taken into account in the study only in so far as this is a precondition required to maintain the presently high level of supply security and ensures the compensation of fluctuations in the demand and production of electrical energy over several hours up to few days (Streicher et al., 2010).

In scientific research, attempts to investigate the role of decentralized renewable energy production are mainly linked with the idea of energy regions (Späth, 2007. Späth & Rohrer, 2010. Kolbmüller et al., 2006). Wolfe 2008 examined the implications of an increasingly decentralized energy system and Hiremath et al. 2009 studied the scope, relevance and applications of decentralized renewable energy in India. Recently also the topic energy autarky was connected to the previous research about one-site renewable energy production. In Müller et al. 2011 energy autarky is presented as a conceptual framework for implementing sustainable regional development based on the transformation of the energy system.

A feasibility study to achieve energy autarky for Austria was published by Streicher/Schnitzer/Steininger et al. in 2010. Till now, there are no analyses on the circumstances how decentralized energy systems in Austria are developing differently and how we are able to force the diffusion of one-site renewable energy production in Austria through a policy mix. Also framework conditions to achieve energy autarky in Austria through its own renewable energy sources are missing till now in literature.

The idea of this research work is to use a socio-technical and multi-level perspective (Geels, 2002) on transitions to study the Austrian energy sector. The ongoing energy transition is driven by developments, changes in rules and visions and social networks that support and oppose renewable options. This policy challenge of governing a socio-technical transition was investigated by Smith et al. 2005. Further, Smith 2007 investigated the multi-level governance of renewable energy in the English regions. Verbong G. and Geels 2007 analyzed the energy transition of the Dutch electricity system (1960-2004) on a multi-level-perspective.

The main research objective of this project is to define a policy mix of economic incentives, regulations and other policy interventions and business models that fosters a rapid adoption of one-site renewable energy in the Austrian energy market. In order to do this in a highly effective and cost-efficient way, the policy mix needs to be adjusted to the respective needs of (potential) participants at different levels. Here we distinguish between three major groups of adopters:

1. Households: How to push forward a highly decentralized energy generation based on renewable resources?
2. Industry: What further side conditions (peculiarities in decision making, limitations for action, etc.) need to be considered for fostering one-site renewables in the business sector (manufacturing industry)?
3. Agriculture: What kind of support is needed to enhance decentralized renewable energy production in terms of citizen solar power plants or similar concepts in a high number in Austria?

Starting from innovation and transition theory- especially market diffusion and adoption theories- the project will lead to a comprehensive understanding of the factors (including psychological, social and cultural factors) that are decisive whether an individual or an organization becomes a potential user at all and under which conditions. Only subsequently, after value-driven processes of awareness building and preliminary consideration, financial and other related economic criteria become crucial for the individual investment decision, i.e. for transforming potential users into real users. This concept goes far beyond a mere empirical analysis of these factors like attitudes, beliefs, preferences and acceptance of the PV technology. The most important scientific value-added is the highly integrated application of two methodological approaches: system modeling and empirical social research – and this in a transdisciplinary setting.

The part “Indicators” deals with the characterization and examination of different transition processes of decentralized energy production in Austria. The focus will be on the initiative and the external and internal settings for the development and diffusion process of on-site renewable energy production. In this context the research questions should investigate which factors are key-drivers for an effective transition process to force the establishment and development of on-site renewable energy production. What kind of governmental and economical adjustments are necessary to give one-site renewable energy a high significance in a sustainable energy system? Furthermore it should be detailed, which different initiatives taken by the Austrian government are taken to promote decentralized energy production in Austria? The methodology includes: literature research, qualitative and quantitative methods of empirical social research (interviews, focus groups, survey, and statistical data analysis) and stakeholder dialogue. This research will be documented and evaluated to gain a broad and sound overview of the subject to explore. To further identify the boosting and blocking key-drivers for decentralized energy production in Austria I will use an empirical study with a survey among stakeholder of Austrian regions and do some interviews with governmental decision makers.

The content of part “Dynamics/Potential” is to take a closer look on the role of decentralized energy production in order to achieve energy autarky through its own renewable energy sources in Austria. Based on the results of the previous part, the research goal lies in developing a set of effective policy recommendations and distribute them to national key-stakeholder and decision makers.

By using a system dynamics model the relationship between decentralized renewable energy production and their indicators should be examined. Main parameters are technological change, economic drivers, legislation and governmental subventions or participation. The aim of the system dynamics model is to identify the relevance of decentralized renewable energy production in order to attain energy autarky in Austria on the long-run. Furthermore, the model should form the foundation to derive and assess policies to promote the diffusion of decentralized energy systems and to increase the amount of renewable energy used in Austria.

One of the great challenges of developing models is in trying to communicate the insights gained to people who did not develop the model. For an easier distribution of the results to stakeholder and decision makers a “flight simulator” should be constructed. This tool allows testing the impact of decisions made in advance. The „flight simulator will be established on the surface of the system dynamics model and consists of different adjustment lever. By using this control panel, policy changes can be transferred to the model and the users can learn about the system and improve their own assumptions about the short and long term effects of different decisions.

The additional scientific results in comparison to state of the art could be summed up as followed:

1. Systematic consideration of user of one-site renewable energy at different levels and thus the possibility to define a policy mix of economic incentives, regulations, target group oriented communication and other policy interventions that is adjusted to the respective needs of users.

2. Strong emphasis on actors' and stakeholders' perspectives: Decisions on the adoption of new technologies in the field of decentralized energy production are not always taken fully rational. Perceptions of and attitudes towards new technologies differ from person to person, from stakeholder group to stakeholder group. There are systemic factors and biases that influence individual and organizational decision making and behavior regarding investments are systematically biased by environmental values or the perception of intertemporal and technological risks. This project put high emphasis on the investigation of these effects, what will be of high interest – not only for policy makers, but also for the international scientific community.
3. Innovative research design by high integration of system modelling and empirical social research: On a solid basis of transition and innovation theory (diffusion and adoption theories) and the analysis of existing international and national experiences the two research streams system modeling and empirical social research are highly interwoven, so that both streams mutually benefit by synergies via additional insights and understandings.
4. Transdisciplinary process of knowledge generation: The installation of a think tank already in the beginning of the project will lead to research results with much higher validity and acceptability in practice. In other words, the result of an integrated process of knowledge production amongst scientists and practitioners is knowledge that is socially more robust (Gibbons and Nowotny 2001).

Summing up, the concept of decentralized energy production refers to an energy system in which energy conversion units are located close to energy consumers. In this research project, the conditional framework to enhance the establishment and development of decentralization of regional renewable energy systems should be investigated. The future challenge lies in building up a sustainable energy management for Austria. The main characteristics of a sustainable energy system are efficiency, reliability, and environmental-friendliness. Local resources and networks are utilized effectively and the introduction of new technologies and political solutions should also be promoted actively. Concluding, on-site energy systems based on domestic renewables are a good option with respect to sustainable development in the long run.

## References

- Geels, F.W. (2002). Technological transitions as evolutionary reconfiguration processes: a multi-level perspective and a case-study. *Research Policy* 32 (2002) 1257–1274.
- Geels, F.W./Schot, J. (2007). Typology of sociotechnical transition pathways. *Research Policy* 36 (2007) 399–417.
- Gibbons, M. and Nowotny, H. (2001), "The Potential of Transdisciplinarity", in Thompson Klein, J., Grossenbacher-Mansuy, W., Häberli, R., Bill, A., Scholz, R.W. and Welti, M. (Eds.), *Transdisciplinarity: joint problem solving among science, technology, and society: an effective way for managing complexity*, Birkhäuser, Basel, pp. 67-80.
- Grin J., Rotmans J., Schot J. (2010). *Transitions to sustainable development -- new directions in the study of long term transformation change*. Routledge, New York.
- Kemp R., Loorbach D., Rotmans J. (2007). Transition management as a model for managing processes of co-evolution towards sustainable development. *Int J Sustain Dev World Ecol* 14(1):78–91.
- Kolbmüller M., Schreuer A., Späth P., 2010. *Entscheidungshilfen für Förderstellen und KoordinatorInnen von EnergieRegionen: Methodenhandbuch*. IFZ und Österreichisches Ökologie Institut, Vienna.

- Loorbach D. (2007). Transition management. New mode of governance for sustainable development. International Books, Kluwer, Utrecht.
- Loorbach D. (2010). Transition management for sustainable development: a prescriptive, complexity based governance framework. *Governance* 23(1):161–183.
- Müller. M.O. et al. (2011). Energy autarky: A conceptual framework for sustainable regional.
- Raven, R. 2007. Niche accumulation and hybridisation strategies in transition processes towards a sustainable energy system: An assessment of differences and pitfalls. *Energy Policy* 35 (2007) 2390–2400.
- Rotmans J., Loorbach D. (2010). Towards a better understanding of transitions and their governance. A systemic and reflexive approach in: Grin J, Rotmans J, Schot J (Hrsg) *Transitions to sustainable development – new directions in the study of long term transformation change*. Routledge, New York, 105–220.
- Shackley S. and Green K. (2007). A conceptual framework for exploring transitions to decarbonized energy systems in the United Kingdom. *Energy* 32 (2007) 221 – 236.
- Smith A. (2007). Emerging in between: The multi-level governance of renewable energy in the English regions. *Energy Policy* 35 (2007) 6266 – 6280.
- Smith/Stirling/Berhout (2005). The governance of sustainable socio-technical transitions. *Research Policy* 34 (2005) 1491 – 1510.
- Smith A. and Kern F. (2008). Restructuring energy systems for sustainability? Energy transition policy in the Netherlands. *Energy Policy* 36 (2008) 4093 – 4103.
- Schneidewind U., Scheck H. (2012). *Zur Transformation des Energiesektors – ein Blick aus der Perspektive der Transition-Forschung*. Wuppertal Institut für Klima, Umwelt, Energie, Springer-Verlag Berlin Heidelberg.
- Späth P., 2007. “Energierregionen”. Wirksame Leitbildprozesse und Netzwerke zur regionalen Gestaltung sozio-technischen Wandels, *Berichte aus Energie- und Umweltforschung* 29/2007. BMVIT, Bundesministerium für Verkehr, Innovation und Technologie, Vienna.
- Späth P., Rohrer H., 2010. „Energy regions“: The transformative power of regional discourses on socio-technical futures. *Research policy* 39.
- Streicher/Schnitzer/Titz/Tatzber/Steininger et al. (2010). *Energieautarkie für Österreich bis 2050. Feasibility study*, Wegener Center Graz.
- Verbong, G./Geels, F. (2007). The ongoing energy transition: Lessons from a socio-technical, multi-level analysis of the Dutch electricity system (1960–2004). *Energy Policy* 35 (2007) 1025–1037.
- Wolfe P. (2008). The implication of an increasingly decentralised energy system. *Energy Policy* 36 (2008) 4509 – 4513.

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**Track 5d:** Planning for sustainable management of water/energy/waste and ecological resources

## Addressing Waste Management Challenges Using a Broader Systems Approach

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### ABSTRACT

Rapid economic growth, urbanization and increasing population have caused materially intensive resource consumption to increase and consequently the release of large amounts of waste in the environment. In future, to manage the resources and wastes sustainably, waste management requires a more system oriented approach. Hence, it becomes important to explore the gaps between current waste management practices in order to have transition towards sustainable waste management. In this paper, some key challenges to waste management systems are highlighted in global context. The study leads to conclusions that the current efforts, rather isolated, in different systems for WM, waste reduction and resource management are indeed not sufficient in a long term sustainability perspective. A broader systems approach to waste management is proposed.

**Keywords:** waste management challenges, systems approach

### 1. INTRODUCTION

In the last few decades, rapid economic development and urbanization has resulted in substantial improvements in well-being for large fractions of the world population. At the same time, we have seen increased materially intensive resource consumption and consequently the release of large amounts of waste to the environment (Wenheng and Shuwen, 2008, Gerbens-Leenes et al., 2010, Blanchard, 1992). Bylinsky (1995) reports that according to the American National Academy of Sciences, 94% of the substance that is pulled out of the earth, enters the waste stream within months.



In the current model of resource consumption, the resources entering into the human environment are being processed, transformed, used and discarded to nature in the form of solid, liquid and gaseous wastes. Waste is regarded as by-products or end products of the production and consumption process respectively (European Union, 2008). From sustainability point of view, it becomes important to properly manage discarded resources. Waste management (WM) hierarchy suggests prevention of waste generation and where it is not possible, the waste materials should be reused, recycled or recovered, or used as a source of energy and as a final measure it should be safely disposed (European Union, 2008). An integrated approach to waste management system (WMS) requires the accounting and controlling of all kinds of emissions (gaseous) and wastes (solid and liquid). So the widest possible definition of *integrated waste management system* could be given as “it is a process of change, in which the concept of waste management is gradually broadened to eventually include the necessary control of gaseous, liquid and solid material flows in the human environment, emphasizing precautionary actions” (Anonymous, 1991).

From the last few decades, WMS have been developing operationally and technologically in response to resolve contemporary environmental, technical and economic challenges. Several studies (Kumar et al., 2009, Zotos et al., 2009, Manaf et al., 2009, Vij, 2012, Salihoglu, 2010, Henry et al., 2006, World Bank, 1999, Zhang et al., 2010, Wilson et al., 2012) around the world has discussed the limitations and challenges to their current WM practices which differs from region to region depending upon the economic development.

In this paper, we have highlighted some of the key challenges to the current WMS in a global perspective. The study lead to conclusions that current global WMS practices suggest ‘end of pipe’ solutions to waste problems rather than long term sustainable measures and these practices need to be discussed with broader aims.

## **2. HISTORICAL DEVELOPMENT OF WMS**

Our current sophisticated WMS have been developing gradually since last five decades. WM activities around the world have been continuously improving in several aspects such as operational, technological and institutional. In 1960s, waste management was just limited to merely removing waste before it becomes health hazard to local population. Main drivers for WM were the contemporary local environmental implications such as pollution and local water body contamination, caused by local dump sites (Wilson et al., 2012). It was considered to be a local environmental problem and considered largely as a technological problem with engineering solutions. With increasing waste amounts and related environmental concerns

with open dumping and open burning of the waste, initial adopted steps were to ban such practices and to develop separate landfill sites as ‘end of pipe’ solutions to the waste problems.

In 1980s, due to increasing energy costs, waste to energy technologies proven economically feasible, leading rapid commercialization of waste to energy (WtE) technologies in high income countries (Sternlicht, 1982, Rylander, 1985, Nakaiwa et al., 1986). It helped municipalities to divert a significant portion of waste from landfills. On the other hand, it offered benefits such as recovered energy and saved landfill area.

In 1990s, due to emerging discussions on sustainability issues, waste issues recognized as a global environmental problem, rather a local environmental problem. Consequently, from the last two decades, WMS have evolved with relatively broader aims to manage waste by creatively minimizing its environmental impacts using technological approaches to manage wastes (especially in high income countries). Studies have shown that since then, consumer’s awareness and institutional relationships in the WM are changing rapidly (Davoudi, 2000). Recently, acute tensions over the development of WM options and the allocation of sites for waste facilities have been observed among society. The waste recycling facilities were developed on industrial scale with the introduction of various operational reforms throughout the product supply chain such as pay as you throw (PAYT) and extended producers responsibility (EPR) (OECD, 2006, USEPA, 2012). Waste incineration technologies have significantly improved over the past years to mitigate and/or treat harmful emissions from incineration. Recently, innovative landfill technologies have been developing due to land scarcity and social opposition to new landfill sites.

In summary, the developing path of the WMS over the past years clearly indicates its development with contemporary ‘short term’ goals. In 1960s, WM was limited to simple disposal guided by the principles of dilution and dispersion in environment as ‘end of pipe’ solutions to the problem. In 1980s, technological developments in WtE and landfill technologies were also ‘end of pipe’ solutions with emphasis on reducing impacts rather than preventing impacts. Technological solutions have developed to achieve high environmental and economic efficiencies; however, with systems view limited to WMS only. WMS have developed with ‘short term’ aims to manage wastes and provides ‘end of pipe’ solutions to the waste problems which are often carried out under economic, technical and environmental constraints. The next section provides the overview of WMS challenges in global context.

### 3. CHALLENGES TO THE GLOBAL WASTE MANAGEMENT SYSTEM

In most parts of the world, municipalities or city administrations are responsible for managing the waste. Due to various factors linked to successful implementation of technological solutions such as institutional, governance and policy frameworks, WMS development throughout the world is highly varied. Low and middle income countries still lack in sufficient basic infrastructure for WM; consequently, unsustainable WM practices are dominant. In high income countries, regardless of relatively developed infrastructure, the WMS suffer challenges such as poor waste sorting making difficult to perform WM operations with desired environmental objectives. Some of the WM challenges in context to global WMS are discussed in below:

#### 3.1 Increasing waste quantities

The waste generation rates are affected by socioeconomic development, degree of industrialization and climate of the region. Generally, the greater the economic prosperity and the higher percentage of urban population, the greater the amount of waste produced.

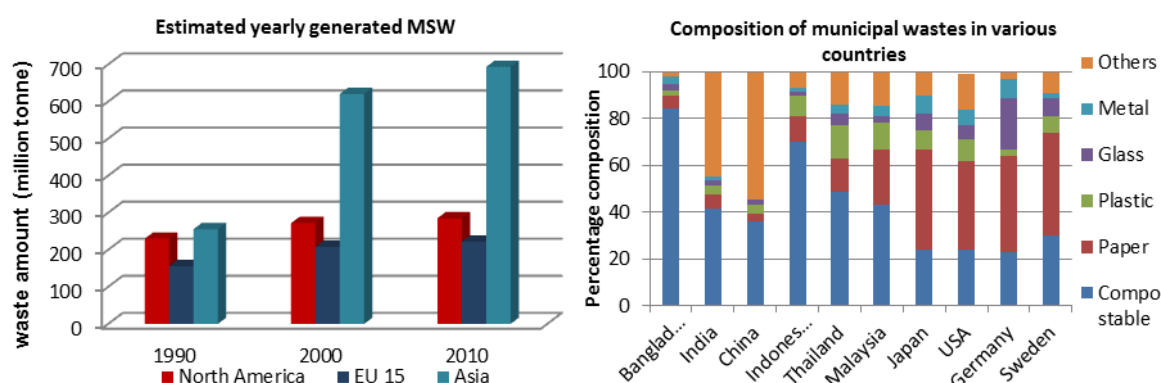


Fig.1 Estimated amounts of daily municipal waste generated and composition of municipal solid waste in different countries. Sources: (Li et al., 2008, OECD, 2000, ESCAP, 2000)

It is evident from figure 1 that *the amount of waste in Asia is increasing at a very fast rate* because of economic development and increasing urbanization. Whereas, in high income countries growth has stabilized, with the fact that *per capita waste (kg/person/day) generated is very high* in such countries as compared to low and middle income countries (see table 1) and still it is increasing, although at very low rate. The waste quantities and compositions not only vary between countries, but also between individual cities and communities within a city depending upon the economic situation of the particular community (see table1 and figure1).

*Table1. Daily waste generation rates [kg/person/day] in large and medium size cities: a global perspective*

<b>Waste amount (mixed) [Kg]</b>	<b>Low income countries*</b>	<b>middle income countries*</b>	<b>High income countries*</b>
Large Cities (>500000 residents)	0,5 to 0,75	0,55 to 1,1	0,75 to 2,2
Medium Cities(100000 to 500000 residents)	0,35 to 0,65	0,45 to 0,75	0,65 to 1,5

Source: The World Bank, 2010 (Münster and Meibom, 2010). \*Classification based on income levels: Low income countries ( $\leq$ UD\$510), middle income countries ( $510 \leq$ US\$ $\leq$ 5,884), High income countries ( $5,884 \leq$ US\$ $\leq$ 40,090)

### **3.2 Simple waste management practices in rapidly growing economies**

Usually, local municipalities are responsible for managing the waste generated in a city or town. However, in many countries, private organizations collaborate with the municipalities to perform WM activities (Jin et al., 2006, Zhang et al., 2010, Bai and Sutanto, 2002, Hazra and Goel, 2009, Kumar et al., 2009). WM activities in parts of the world differ in many aspects. In high income countries, WM includes highly industrialized recycling activities, high-tech mechanized machinery, sanitary landfills with gas and leachate collection and treatment facilities. However, low and middle income countries WM solutions are highly ‘end of pipe’ solutions. Open dumping is prevalent in such countries. For example, in China approximately 90 % of MSW is disposed of in ordinary and simple landfills (Zhang et al., 2010). The present local environmental situation is deteriorating rapidly due to increasing urbanization and increasing waste amounts (cf. figure 1). Furthermore, it causes difficulties in getting public approval for development of new landfill sites and at economically acceptable distances from a collection area.

Because of lack of planning and other pressing factors such as landfill area scarcity, municipalities constrained to choose unsustainable WM practices, for example prioritizing solid waste incineration over other waste disposal methods although it is more expensive (Jin et al., 2006, Bai and Sutanto, 2002). The stringency of legislation on WM practices also varies in different countries. In low and middle income countries, legislation is less stringent as compared to the high income countries.

### **3.3 Environmental awareness and participation of people in WM**

The level of environmental awareness motivates consumers towards a sustainable behaviour such as judicious use of the products (resources), responsible disposal. This directly affects

waste sorting and hence the overall efficiency of the WMS. In low income and middle countries, one of the reasons for a lack of environmental awareness could be the inadequate educational institutions. In high income countries, people consider the disposal of waste as a significant environmental concern, but it is not an issue at the forefront of their minds. Consequently there is often a poor participation. Studies have shown a strong concern among people for a clean environment and the belief that learning, information and awareness campaigns are important drivers to behaviour change (Mbeng et al., 2009). However, this does not necessarily translate into an increased participation in recycling or reuse initiatives.

There is a lack of understanding about how waste problems are linked to global issues such as climate change, which is an issue that people are particularly aware of and concerned about. The challenge is to successfully make the association between people's waste disposal behaviour and global concerns in the same way as they have linked climate change to car use and local flooding (MORI, 2002).

### **3.4 Lack of resources and well organized institutions**

Because of lack of inadequate manpower, financial resources, absence of well-organized institutions and infrastructure WM operations, low and middle income countries rely on low technology solutions (Kumar et al., 2009). Informal sectors for waste collection are highly active in these countries. Indeed, there are twice as many people in the informal sector as those in the formal sector (WorldBank, 2005). Unfortunately, these informal waste collection systems make it more difficult to regulate and implement an efficient and standardized waste treatment system. Overall sustainability requires regulating and operating such informal recycling economies to make better use of such developed systems.

Recently, high income countries have been emphasizing much on the understanding of WM as a system. Resources are allocated on collecting and analyzing the waste related information for example waste quantity, composition, by using computer based simulations programs, which is not common in low and middle income countries. Whereas, low income countries still are struggling to resolve basic institutional, operational and management issues.

### **Overall global WMS Development**

Literature survey suggests a map of the WMS in different parts of the world, as presented in table 2. The number of plus signs indicates the intensity of a particular issue.

*Table 2. An attempt to map the waste management in different parts of the World*

<b>Issue</b>	<b>Low income countries</b>	<b>middle income countries</b>	<b>High income countries</b>
Increasing waste quantities	++	+++	+
Simple waste management practices	+++	++	+
Environmental awareness & participation of people in WM	+	++	+++
Lack of resources and well organized institutions	+++	++	+
Lack of intellectual resources	+++	++	+
Lack of links between production, consumption & WMS	+++	+++	++
<b>Overall seriousness of existing problems in the production, consumption and WMS</b>	+	++	+++

There is still an inextricable link between economic growth and waste amounts. In low and middle income countries, per capita waste generation rates are not very high but are increasing at very fast rate. However, the absolute volumes are much bigger in such countries as compared to high income countries. Whereas, in high income countries the per capita waste generation rates are already very high and are still increases with economic growth. Based on this, it could be argued that the waste problems are much more serious in such countries.

It shows the dominance of linear model of resources consumption in the economies throughout the world. From resource depletion perspectives, it requires a transition towards a circular model of resource consumption, where resources reuses and recycle are motivated through strategic planning throughout the product consumption chain. However, waste issues are not discussed together with production and consumption hitherto.

It is evident that WMS operations in high income countries are relatively advanced as compared to low and middle income countries. Whereas, low and middle income countries still lacks sufficient basic infrastructure for WM. There is a strong need to develop WM infrastructure in such countries.

In high income countries, regardless of relatively developed WM infrastructure, such as waste collection, material recovery and treatment, WMS faces several operational, technological and

environmental challenges. WM operations carried out with conflicting environmental and economic objectives, such as, preference of incineration over recycling or landfill over incineration. Such challenges are not only rooted in the technological solutions or in social participation but they are extended to the product design.

Current WM practices appear to be ‘end of pipe’ solutions rather than a holistic solution. It could be argued that overall global WMS development is not on a sustainable trajectory. Hence it becomes important to discuss waste issues with broader aims to reduce the net flows of residues/wastes throughout the chain of resource extraction, production, consumption and WM system.

#### **4. A BROADER SYSTEMS APPROACH TO WMS**

Recently, waste issues have recognized as a global environmental problem, rather a local environmental problem. Significant contribution of waste related emissions to global environmental problems such as climate is evident from various studies. Waste related greenhouse gas (GHG) emissions are estimated to be 2-4% of total GHG emissions and are expected to increase to 9% in 2020 with business as usual (UNFCCC, 2005).

WMS is interlinked with production and consumption systems through designers, manufacturers, retailers and consumers. It can provide benefits and impact system management beyond the traditional boundaries of WM and impact urban resources management (Wilson et al., 2001). It requires addressing the issues embedded in the linear model of resources consumption, that is, the way resources are used and managed in our society.

The proposed broader systems approach to WM presented here is based on limitations in current approaches to waste management that suggests more of ‘end of pipe’ solutions to waste problems due to its fragmented systemic view. This approach suggests the study of metabolism of the broader system to identify main barriers and opportunities for sustainable resource management. To achieve desired common goals to increase resource use efficiency throughout the system requires aligning efforts with production and consumption and WM systems, regardless of borders. Various system interactions with well-defined system objectives are shown in fig.4. A much needed transition from a linear to circular model of consumption should be based on broader systems aims as follows:

- To reduce the net flow of wastes/residues throughout the system of production, consumption and WM
- To maintain the quality of resources (entropy profile) through product consumption chain to improve reuse and recycling of resources
- To align resource management efforts globally

**To reduce the net flow of wastes/residues throughout the system of production, consumption and WM:**

Growing amounts of wastes throughout the world, especially in the low and middle income countries, present a vital challenge for current WMS. It is mainly due to linear model resource consumption and increasing consumption of short life span products.

To reduce the flow of wastes/residues to WMS requires fostering reuse, recycling, repair and remanufacturing in the upstream systems of production and consumption. This would not only reduce the requirement of virgin material extraction, but also provide additional benefits of reduced waste flows from production and resource extraction processes.

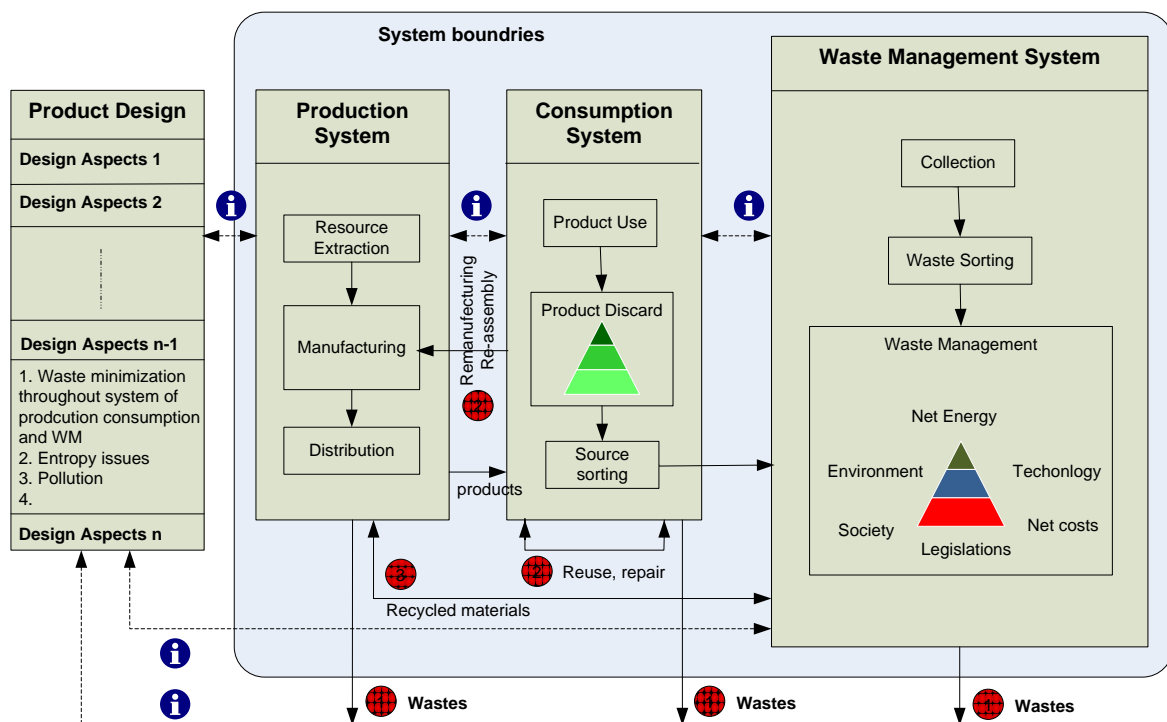


Fig. 4 Different system interactions, processes and information flow in a broader system.

To handle waste due to consumable products with short life span, innovative resource management strategies at regional or national level should be designed. For example, increase



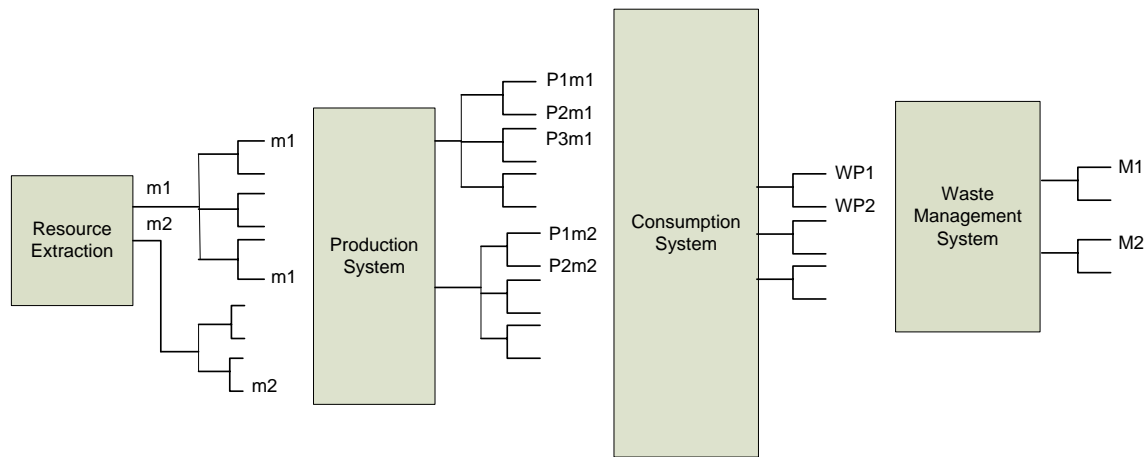
recyclability and preserve resources in a closed loop, use of precious materials such as aluminum for packaging. The use of renewable material can be promoted which after first use can easily be treated or biologically handled or incinerated to produce energy. For durable products (with relatively long life span), concept of precycling, meaning actions taken now to prepare for current resources to become future resources, can very well employed by correcting whatever error allows it to become waste or make unsuitable to manage sustainably (Greyson, 2007).

WM hierarchy suggests preference of recycling over other WM options such as landfilling and energy recovery. However, the choice of WM options is highly constraint by various factors such as costs, net energy and environmental benefits. Moreover, in practice, sorting efficiencies and social participation put limitations on efficient recycling.

Barriers to efficient recycling or remanufacturing are not only limited to technological implications or social participation but they are extended to the product design. The waste issues and WM challenges can be simultaneously addressed at early stage through integrated product design approaches, meeting physical design requirements as well as incorporating other systems goals such as remanufacturing, reassembly and easily manageable waste.

### **To maintain the quality of resources (entropy profile) through product consumption chain**

Diversity of products/resources flowing through human environment has been increasing from last few decades. Various resources transformed into different products in production systems acting globally. The products distributed to consumers finally get discarded to WMS. The resources undergo several transformations from its 'cradle to grave'. Entropy profile, indicator of quality of a particular resource at a stage of its lifespan, varies throughout product consumption chain. To foster efficient cycles of reuse, remanufacturing and reassembly, it is important maintain the resource quality throughout the product consumption chain. Study of entropy profile for various resources can be helpful in addressing causes for material losses throughout the system, and consequently in planning and implementing strategies for resource management.



*Fig. 5 Flow of resource material m1 and m2 with changing through resource consumption chain. Concentrated resource m1 enters the production system and transformed into various products (P1, P2, and P3) with decreased concentration. Finally, it gets disposed with the product discard, further decreases its concentration.*

Waste materials discarded to WMS exceed very much in numbers and variety. Whereas, waste fractions collected by the WMS typically ranges from 7 to 15 in different parts of the world depending upon its infrastructure, which results several operational challenges for WMS such as poor sorting. In this respect, product design can play important role, for example, by designing products with similar type of material requirements in order to maintain entropy profile so that it can be managed efficiently once discarded.

Different products and recyclable waste materials contain additives/contaminants which are unwanted in a recycling context. These contaminants pose problems either because they limit downstream recycling or utilization options for waste materials or because the contaminants may accumulate during recycling, potentially to a level where recycling is not feasible. Also they can cause ecological damage when released into the environment. Product design can also help to select and/or reject materials, substances, chemicals suitable or easily manageable during WM operations.

### **To align ‘fragmented’ resource management efforts globally**

In 1990s, we have witnessed emerging discussions on sustainability leading to increased consumer awareness about products’ environmental performance. Several initiatives such as cleaner production, design for environment, extended producer responsibility (EPR) and industrial symbiosis were introduced in production system in order to address the sustainability issues. Such technological and operational developments have recognized the need to include production system to achieve the needed resource efficiency. However, they

focus predominantly on the individual product or system in isolation rather than on a more coherent systems approach. Such ‘fragmented’ efforts should be aligned at regional or national levels with common resource management objectives.

Materials for the production of manufactured items come from all over the world, customers are often international, and many products may be subject to subsequent recycling or disposal far from the country of origin. Hence, EPR is a global issue, presenting a challenge to materials and waste managers worldwide, regardless of country boundaries. This calls for the implementation of EPR programs worldwide, not only in countries with sophisticated WM infrastructures (Rotter, 2011).

## **5. FINAL REMARKS**

WMS in high income countries is relatively much developed as compared to low and middle income countries. However, the overall WM system development globally is not yet considered to be on sustainable trajectory due to its ‘end of pipe’ approaches to waste issues.

Waste issues and WM challenges are characterized by high levels of complexity and uncertainty and should be approached from different perspectives. Various critical systems dynamics (systems interactions, processes, stocks, stakeholders) should be identified. Then positive drivers and mechanisms among different actors need to be identified and strengthened. This requires information flow between different actors and systems through well-defined system objectives, legislations and role of all individual systems from product design to final disposal.

The production, consumption and WM chains are active at local as well as global levels and operational realities differ greatly from system to system, making any direct, quantitative comparison extremely difficult. These differences are marked by demographic, methodological, operational, financial, and institutional variables, as well as the difficulty of any inter-country comparison. However, qualitative commonalities for good system management do exist (Wilson et al., 2001). These commonalities can be innovatively aligned to address waste issues globally. This transition may require dramatic shift from current practices and may demand new institutional and policy arrangements.

To move the interlinked social and ecological systems in the direction of greater resilience and sustainability requires complex system perspectives that recognize the dynamic link between the social, ecological, and technological subsystems. Dealing with resources

responsibly is a challenge not only to producers but also to municipalities, the recycling industry and, last but not the least, to consumers (Rotter 2011). It may require radical, systemic shifts in deeply held values and beliefs, patterns of social behaviour, and multi-level governance and management regimes. But we believe that a connected global society has the means to quickly respond to change and stimulate innovations on a planetary scale.

## 6. REFERENCES

- ANONYMOUS 1991. Elaboration of a Regional Strategy on Integrated Waste Management. In: CHAIR B., F. (ed.) *Report from an ECE task force*. United Nations
- BAI, R. & SUTANTO, M. 2002. The practice and challenges of solid waste management in Singapore. *Waste Management*, 22, 557-567.
- BLANCHARD, O. 1992. Energy consumption and modes of industrialization: Four developing countries. *Energy Policy*, 20, 1174-1185.
- BYLINSKY, G. 1995. Manufacturing for reuse. *Fortune*, 131, 102-103.
- DAVOUDI, S. 2000. Planning for waste management: changing discourses and institutional relationships. *Progress in Planning*, 53, 165-216.
- ESCAP 2000. The State of Environment.
- EUROPEONUNION 2008. EU Framework Directive on Waste. Official Journal of the European Union.
- GERBENS-LEENES, P. W., NONHEBEL, S. & KROL, M. S. 2010. Food consumption patterns and economic growth. Increasing affluence and the use of natural resources. *Appetite*, 55, 597-608.
- GREYSON, J. 2007. An economic instrument for zero waste, economic growth and sustainability. *Journal of Cleaner Production*, 15, 1382-1390.
- HAZRA, T. & GOEL, S. 2009. Solid waste management in Kolkata, India: Practices and challenges. *Waste Management*, 29, 470-478.
- HENRY, R. K., YONGSHENG, Z. & JUN, D. 2006. Municipal solid waste management challenges in developing countries – Kenyan case study. *Waste Management*, 26, 92-100.
- JIN, J., WANG, Z. & RAN, S. 2006. Solid waste management in Macao: Practices and challenges. *Waste Management*, 26, 1045-1051.
- KUMAR, S., BHATTACHARYYA, J. K., VAIDYA, A. N., CHAKRABARTI, T., DEVOTTA, S. & AKOLKAR, A. B. 2009. Assessment of the status of municipal solid waste management in metro cities, state capitals, class I cities, and class II towns in India: An insight. *Waste Management*, 29, 883-895.
- LI, M., ZHAO, Y., GUO, Q., QIAN, X. & NIU, D. 2008. Bio-hydrogen production from food waste and sewage sludge in the presence of aged refuse excavated from refuse landfill. *Renewable Energy*, 33, 2573-2579.
- MANAF, L. A., SAMAH, M. A. A. & ZUKKI, N. I. M. 2009. Municipal solid waste management in Malaysia: Practices and challenges. *Waste Management*, 29, 2902-2906.
- MBENG, L., PROBERT, J., PHILLIPS, P. & FAIRWEATHER, R. 2009. Assessing Public Attitudes and Behaviour to Household Waste Management in Cameroon to Drive Strategy Development: A Q Methodological Approach. *Sustainability*, 1, 556-572.
- MORI 2002. Public Attitudes Towards Recycling and Waste Management. MORI Social Research Institute.
- MÜNSTER, M. & MEIBOM, P. 2010. Long-term affected energy production of waste to energy technologies identified by use of energy system analysis. *Waste Management*, 30, 2510-2519.
- NAKAIWA, M., KAWASAKI, S., NAKA, Y., BABA, K. & TAKAMATSU, T. 1986. Design of electric power generation systems using waste heat energy. *Energy Conversion and Management*, 26, 277-281.
- OECD 2000. Database on Environment.
- OECD. 2006. *EPR Policies and Product Design: Economic Theory and Selected Case Studies* [Online]. Available: [http://www.oecd.org/document/19/0,3746,en\\_2649\\_34281\\_35158227\\_1\\_1\\_1\\_1,00.html](http://www.oecd.org/document/19/0,3746,en_2649_34281_35158227_1_1_1_1,00.html) [Accessed 1 May 2012].
- ROTTER, V. S. 2011. Waste management and producer responsibility: a score behind - a new ahead. *Waste Management & Research*, 29, 889-890.

- RYLANDER, H. 1985. Waste management in Sweden. A national report. *Waste Management & Research*, 3, 81-88.
- SALIHOGU, G. 2010. Industrial hazardous waste management in Turkey: Current state of the field and primary challenges. *Journal of Hazardous Materials*, 177, 42-56.
- STERNLICHT, B. 1982. Waste energy recovery: An excellent investment opportunity. *Energy Conversion and Management*, 22, 361-373.
- UNFCCC 2005. Key GHG Data. Greenhouse Gas Emissions Data for 1990-2003 Submitted to the United Nations Framework Convention on Climate Change. In: SECRETARIAT, U. (ed.). Bonn, Germany.
- USEPA. 2012. *Resource conservation and tools* [Online]. Available: <http://www.epa.gov/osw/conservation/tools/payt/> [Accessed 1 May 2012].
- WENHENG, W. & SHUWEN, N. 2008. Impact Study on Human Activity to the Resource-environment Based on the Consumption Level Difference of China's Provinces or Autonomous Regions. *China Population, Resources and Environment*, 18, 121-127.
- VIJ, D. 2012. Urbanization and Solid Waste Management in India: Present Practices and Future Challenges. *Procedia - Social and Behavioral Sciences*, 37, 437-447.
- WILSON, D. C., RODIC, L., SCHEINBERG, A., VELIS, C. A. & ALABASTER, G. 2012. Comparative analysis of solid waste management in 20 cities. *Waste Management & Research*, 30, 237-254.
- WILSON, E. J., MCDUGALL, F. R. & WILLMORE, J. 2001. Euro-trash: searching Europe for a more sustainable approach to waste management. *Resources, Conservation and Recycling*, 31, 327-346.
- WORLDBANK (ed.) 1999. *What a Waste: Solid Waste Management in Asia*, Washington, D.C.: The World Bank.
- WORLDBANK 2005. The World Bank, Waste Management in China: Issues and Recommendations, Urban Development Working Papers No. 9, East Asia Infrastructure Department.
- ZHANG, D. Q., TAN, S. K. & GERSBERG, R. M. 2010. Municipal solid waste management in China: Status, problems and challenges. *Journal of Environmental Management*, 91, 1623-1633.
- ZOTOS, G., KARAGIANNIDIS, A., ZAMPETOGLU, S., MALAMAKIS, A., ANTONOPOULOS, I. S., KONTOGIANNI, S. & TCHOBANOGLU, G. 2009. Developing a holistic strategy for integrated waste management within municipal planning: Challenges, policies, solutions and perspectives for Hellenic municipalities in the zero-waste, low-cost direction. *Waste Management*, 29, 1686-1692.

## **Sustainable Food, Energy and Water (FEW) Development: The FEW Security Model**

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### **Abstract**

Sustainable food, energy and water security belong to the basic needs of nations. This paper builds a food, energy and water (FEW) security model with which different countries can assess their current state and future developmental needs of FEW security based on globally sustainable development. The FEW security analysis cube is built from its various building blocks, i.e., dimensions, taking their relationships and reflections into account. The resulting model is tested in four different kinds of countries: Finland, Bolivia, Bhutan and Botswana. Conclusions are drawn on the potential practicability of the model in analysing the food, energy and water security of nations, and further research plans on the other levels of needs of nations are discussed.

### **Introduction**

The past and present organizational form of the world is nations' society. Regional unions, such as the European Union (EU), the Latin American Economic System (SELA), the Asia-Pacific Economic Cooperation (APEC), the Asia Cooperation Dialogue (ACD) and the African Union (AU) have remained politically weak organizations. The low-profile appointments to the EU's two top offices, presidency and foreign affairs, in 2009 exemplify the member states' wish to keep regional unions weak. Nations rule, and their power struggles create conflicts between them. The dark side of nation states inspired some of the lyrics for John Lennon's song *Imagine*: "Imagine there's no countries. It isn't hard to do. Nothing to kill or die for..." However, as long as nation states exist, their needs must be addressed constructively, in order to minimize the problems.

Maslow's (1943) individual hierarchy of needs can be applied to nations. They can be described briefly in the following way:

Level 1: *Physiological needs* of nations: water, food and energy.

Level 2: *Safety needs* of nations: sovereignty and peace.

Level 3: *Social needs* of nations: good relations and cooperation with others.

Level 4: *Esteem needs* of nations: respect by/of others.

Level 5: *Self-actualization needs* of nations: morality and creativity.

Level 6: *Self-transcendence needs* of nations: united consciousness.

It is often thought that these needs should be met in this order, but in reality that is not the case with individuals, organizations or societies. At societal level, each country tries to secure the fulfilment of the different level needs in its own characteristic way. The distinctive way a nation adopts does not necessarily depend on its material development stage, but rather on the values of its people and leaders. For example, it could be claimed that Finland emphasizes the maximum fulfilment of physiological and safety needs, Botswana social needs, Bolivia esteem needs, and Bhutan self-actualization and self-transcendence needs. The argument will be discussed later in this and subsequent papers.

These different need emphases are one reason for choosing Finland, Bolivia, Bhutan and Botswana as case examples. In addition, these countries are from different continents, which gives chances for locality comparisons. On the other hand, all four countries have small

populations, and, therefore, they should be able to meet their citizens' needs more easily than large population countries. I am a Finn and my expertise is currently limited to analyses of small countries – the needs and their fulfilment of large countries, like the BRIC countries, i.e. Brazil, Russia, India and China, are on a much larger scale than those of small countries the analyses of which can be more focused.

Since examining all these different level needs leads to complex analyses that go beyond one paper, I shall write several papers and analyse and compare only few needs at a time. The final paper will integrate the findings and draw holistic conclusions.

My study starts from level 1: this paper investigates the basic national needs of food, energy and water (FEW). The most critical challenges facing nations in the next decades involve securing fresh water, food and alternative energy supplies. The basic needs of people are: water to drink, food to eat, and energy to boil water, cook food and keep warm. Meeting these needs is crucial for the survival of the citizens. There is no nation without citizens. Different political ideologies see the role of citizens in different ways: the currently prevailing capitalist ideology reduces citizens to producers and consumers, communism to producers and informers, and militarism to cannon fodder. Yet all nations and their leaders need people to govern. That is why countries strive for securing the sustainable supply of food, energy and water.

It might be argued that there are other, equally crucial, basic needs to be met, such as health services and forest conservation, but they are not really national needs. Health is an individual need, and although the general level of health of citizens is important to a nation, people will always hurt themselves, get ill and die – these are inevitable consequences of living and aging. Pandemics like influenzas are global, not national issues. The HIV/AIDS has hit some countries harder than others – in Swaziland the HIV infection rate has been 26.1% and in Botswana 23.9% (Kaiser Family Foundation, 2008) and in both countries AIDS has killed about 2 per cent of adults every year (WHO, 2006a; WHO, 2006b), leaving children orphans and paralyzing the country's economic and socio-cultural development – but no country should be left alone to fight it; instead its prevention and treatment should be global concerns.

Forest conservation is also a major global issue. Forests protect the biological heritage of this planet, i.e., the biodiversity comprising plants, animals and ecosystems. In addition, forests absorb carbon dioxide emissions travelling from all parts of the globe. These greenhouse gases do not know any national boundaries but fly freely in our atmosphere. Hence forest conservation is not just a national concern but also a local and global task.

Why then should food, energy and water be national issues? Shouldn't they, too, be solved both locally and globally at the same time? In a fair world this would be a reasonable expectation. Everyone should have enough nourishing food, clean water and energy at their disposal. Our current world is not fair, though. Nations fight over food, water and energy. They do not fight over who can save lives or forests more or most. What a researcher can do in this situation is to help leaders and citizens to understand the interdependent nature of food, energy and water need fulfilment between nations. A country that solves its food, energy or water needs at the expense of others will have to pay for it sooner or later. Since climate change accelerates the speed of environmental changes leading to drastic socio-cultural and economic changes with exponentially growing numbers of climate refugees, that day will come sooner rather than later. It is understandable and acceptable that nations wish to survive and prosper and, therefore, secure their food, energy and water supplies – as long as this can be done without compromising the similar efforts of others.

The *purpose* of this paper is to build a food, energy and water (FEW) security model with which different countries can assess their current state and future developmental needs of FEW security based on globally sustainable development. In this endeavour, various dimensions, relationships and reflections must be taken into account.

**Dimensions:** Food, energy and water supply issues integrate the environmental, socio-cultural and economic dimensions of sustainability. These dimensions are the fundamental building blocks of a FEW security model.

**Relationships:** In some situations, food, energy and water needs can be met parallel. The solution of one need may even enhance the solution of another need. In other situations, conflicts arise from trying to meet food, energy and water needs simultaneously: a solution to one need may harm or even destroy the supplies of another need.

**Reflections:** The levels of needs are not independent of each other, but interact. Some solutions may help a nation to meet different level needs at the same time. When the different level needs clash, a nation will prioritize some needs over others or make compromises between them. That is why already in this level 1 needs' research other level needs must be discussed as intervening variables.

According to the Food and Agriculture Organization, *food security* “exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food which meets their dietary needs and food preferences for an active and healthy life” (FAO, 2003: 29). Definitions for energy and water security can be derived from this food security definition. Hence *energy security* exists when all people, at all times, have physical, social and economic access to sufficient, safe and sustainable energy, which meets their energy needs and preferences for an active and healthy life. Similarly, *water security* exists when all people, at all times, have physical, social and economic access to sufficient, safe and clean water, which meets their water needs and preferences for an active and healthy life.

The rest of this paper will progress in the following way. First the food, energy and water (FEW) security analysis cube will be built from its various building blocks. The resulting draft model will then be tested in four different kinds of countries, Finland, Bolivia, Bhutan and Botswana. The data for the country cases will be derived from secondary sources: scientific journal articles, newspapers and web pages. Finally, conclusions will be drawn on the potential practicability of the model in analysing the food, energy and water security of nations, and further research plans will be discussed.

## **Food, Energy and Water (FEW) Security Analysis Cube**

### *Food*

In the 21<sup>st</sup> century world, food is a global market commodity and foreign food is eaten in all countries together with local food. There would be shortage of many foodstuffs if imports suddenly ceased. The level of food security would then be revealed: if the citizens still managed to continue a balanced diet and found substitutions with necessary nutrients to previously imported food, the level of national food security would be satisfactory. This is one reason why developed countries subsidize their agriculture. The governments of many developing countries either have no resources to support local agriculture or focus rather on other issues, such as rapid economic growth, which results in dwindling opportunities for non-export farming and vulnerability to food crises. Moreover, the environmentally malignant effects of climate change, desertification and floods and their combined impacts, tend to hit these countries harder than developed countries, decreasing their fertile soil area available for farming dramatically.

In many developed countries there is overproduction of food, even of basic foodstuffs like corn, resulting in farm fields left lying fallow with the assistance of subsidies, and excess foodstuffs dumped onto the markets of developing countries, so that local farming there becomes unprofitable, farmers lose their livelihoods and cannot afford to buy food for their families. While the wealthy overeat the poor go hungry.

Despite this gross imbalance developed countries wish to protect their future food supply at the expense of developing countries. In politically, economically and ecologically unstable times most countries wish to pay special attention to securing national food supplies for the future. Populous and rich countries have started to buy and lease farmland from developing countries to secure their own food supplies: e.g. China 1.24 million hectares (ha) from



Philippines, South Korea 1.3 million ha from Madagascar and 690,000 ha from Sudan, United Arab Emirates 324,000 ha from Pakistan, and Libya 100,000 ha from Mali (von Braun and Meinzen-Dick, 2009). The purchasers or leasers are either states or corporations.

The International Food Policy Research Institute estimates that during 2008-2009 about 20 million hectares of agricultural land were handed over to foreigners in developing countries (von Braun and Meinzen-Dick, 2009). The reasons are obvious. Political and economic circumstances change fast and may suddenly stop food imports or multiply the price of food. Additionally, in oil-wealthy Arab countries desertification has been progressing so fast that soon farming will be impossible on nearly all of their land area. Their farming has been dependent on irrigation, which becomes practically impossible to maintain because of prolonged periods of lack of rainfall, which reduce the water levels of waterways, and because of sea level rise, which turns vast areas infertile. Asian countries have such large numbers of inhabitants that even partial desertification and/or flooding may cause shortage of food. China also suffers from major irrigation problems on its vast fields it needs to feed its 1.337 million citizens, and from quickly growing cities that conquer farmland.

But the target countries of their conquests are also suffering from desertification and/or flooding, irrigation problems, urbanization, food price changes and potential import restrictions – and still they are selling or leasing their most fertile and least draught/flood vulnerable areas. So far there has been little open opposition to such deals; if local people voice their dismay, the government silences them because of the cash or promised infrastructure. If the living conditions deteriorate slowly, protests may spread, but rapidly increasing hunger will not lead to demonstrations because hunger makes people too weak to act. Hence the fact is that rich countries will be producing their food freely on the farms of poor countries at a low local cost and taking them to their home countries free of charge.

It is the rich or immensely populous countries that may fight food wars amongst themselves for the poor countries' farmlands in the future. All self-confident nations want to be self-sufficient and not dependent on other countries in food production. Securing national food production is an acceptable goal. However, instead of conquering and fighting over other nations' food supplies and destroying their fields with intensive, large-scale, chemically enhanced farming, they could develop their own domestic farming towards non-eroding, conserving forms, such as organic, small-scale, subsistence farming, which respects ecosystem biodiversity and cultural traditions, and employs many, many more of their inhabitants. Sustainable food production and food security start at home.

### *Energy*

Oil wars have been fought for a century particularly in the Middle East and Central East Asia because oil-producing countries have had a powerful weapon to force their views through in global politics and economics. Non-oil-producing countries have been dependent on their crude oil supply. Now that climate change is motivating countries to develop renewable energy forms, the power of oil-producing countries is threatening to diminish. Renewable energy production, such as solar, wind, wave and biomass power, is typically a local activity, resulting in independent power supplies for communities and nations. Energy security is just as strong incentive for countries to invest in renewable energy as climate change. Even countries like China, the USA, India, Australia, Russia and South Africa, which have enormous coal reserves, take renewable energy opportunities seriously. They need all energy available to boost their economic growth. China has committed to reducing its carbon intensity – carbon dioxide emissions relative to gross domestic product (GDP) – by 40-45 per cent from 2005 level by 2020, which means that with the GDP soaring, the actual CO<sub>2</sub> emissions will be rising. While increasing energy efficiency will take care of much of this relative reduction, renewables are needed to offset the malignant effects of coal. Renewable energy seems to be an endless source of technological, economic, social, cultural and environmental innovations in which research and development (R&D) is flourishing. Yet mere local renewables development does not seem to be enough for some countries.

Populous and rich countries have started to buy and lease farmland from developing countries to secure their biofuel supplies: e.g. China 2.8 million ha palm oil plantation from Democratic Republic of Congo and 2 million ha for jatropha from Zambia, and Sweden 100,000 ha for biofuel crops from Mozambique (von Braun and Meinzen-Dick, 2009). The pattern resembles the way in which the rich and populous nations have conquered countries with oil and gas resources. Their next conquests will be land and sea area owned by developing countries captured for solar, wind and wave energy production as soon as their storing and transporting problems have been solved. The gradual removal from unrenewable to renewable energy forms is reflected on the kind of raw materials these nations now want to grab. Although renewable energy is marketed as an ethical option, the actual renewable energy production is no more ethical than fossil energy production. The same unethical ways of behaviour are appearing, and eventually leading to energy wars.

Developed countries look after their socio-cultural energy security by building centralized energy systems in urban areas and decentralized energy systems in rural areas. Most developing countries cannot afford to build infrastructure for centralized energy systems in their urban areas and even if they could, e.g. through development cooperation or aid, most of their citizens could not afford to buy the service. Urban households, companies and other organizations in developing countries are, therefore, interested in similar small, decentralized energy systems to the ones introduced in their rural areas and based on cultural traditions.

Many nations are currently building a number of new nuclear power plants, and even those countries that decided after Chernobyl to gradually phase out nuclear power altogether are taking back their promise. Corporations in the developed world advocate nuclear energy as *the* solution to climate change, ignoring its major malignant impacts and hazards: the mining, transporting, utilizing and disposing of radioactive uranium and fuel made of it cause huge environmental, health, safety, security and economic problems at every stage of the process and destroy indigenous cultures and traditions in both the uranium production and nuclear waste dumping sites. The only way nuclear energy is better than other unrenewable energy forms, such as oil and gas, is that during the actual energy production it does not cause carbon dioxide emissions, although during its building, mining and all transportation stages CO<sub>2</sub> emissions are plentiful. From all these points of view, renewable energies – solar, wind and wave – are environmentally, socio-culturally and economically secure energy forms.

### *Water*

Drinking water is the most important substance for humans to survive. In the developed areas drinking water is tap water, in developing areas pump water, both of which usually come from either groundwater wells or rainwater ponds, but decreasingly from lakes or rivers, which are mostly too polluted to have drinkable water. Only in remote areas, not connected to other waterways, you may find a spring with clean water – if airborne emissions have not polluted it. Cleaning contaminated water is possible but for large-scale continuous use both expensive and only partial. The quality and taste of treated water does not equal those of fresh water.

Climate change causes both lack of rain, leading to draught, and excessive rain, leading to floods. Lack of rain lowers groundwater levels, which means that drinking water becomes scarce. If it rains hard after a long period of draught, dry soil cannot absorb the excessive amounts of rainwater, resulting in no rise in groundwater levels but in floods, which spread hazardous substances dissolved into surface water from overflowing sewages and other industrial, agricultural and household sources. Gradually soil absorbs some of it. If groundwater becomes contaminated, or if rain falls as acid rain, people are in trouble. Poor people have to drink polluted water even from stagnant water ponds while wealthy people buy bottled water produced elsewhere, often abroad, and transported by road or sea to these lucrative markets. In some cities in India and African countries the poor buy water from tanker trucks circulating around the slums. Tanker water is much more expensive than tap water.

Since global warming – lack of rain and shrinking glaciers – lowers the water level of lakes and rivers in the problem areas, they cannot solve the fresh water problem even with the help of water purification plants. Seawater can be turned into drinking water only after major multi-stage treatments that are very expensive. So far even wealthy seaside Arab countries suffering from persistent drinking water shortages rather import water from abroad in tanker ships than desalinize massive amounts of seawater.

The global need for water will increase by 40 per cent over the next 20 years because of population growth of 50 million a year (Kropp, 2009). Yet water reserves are shrinking even at a higher rate due to unsustainable water use practices and climate change. Water may become a major cause for wars in the future. Water conflicts on household water and irrigation have been taking place in the Middle East and Northern Africa for thousands of years; the names of states change, but the rivers remain the same. Nowadays Israel, Palestine, Jordan, Syria and Lebanon fight over water rights and distribution of the Jordan. The Euphrates and Tigris river basin conflict involves Turkey, Syria and Iraq. Ten countries along the Nile each want to direct more water onto their fields and into their towns and cities.

Similar regional disputes will become more widespread as desertification progresses in Africa, Asia, Europe and America. Currently the worst hit areas include the Sahel (a belt running through Senegal, Mauretania, Mali, Burkina Faso, Niger, Northern Nigeria, Chad, Northern Central African Republic, Sudan, Ethiopia, Eritrea and Djibouti) as well as North Western India, Northern and Western China, Spain, North-Eastern Brazil, Mexico, Southern and Western states of the USA and Australia.

Some currently fresh water secure areas, such as the Nordic countries, will have increased precipitation due to climate change, which means that they may be able to sell water to the rising number of fresh water insecure countries – unless the climate change refugees migrating from northwards cause them a population explosion. In any case, few small northern countries cannot solve the problem: their water supplies are miniscule compared to the thirst of billions of southern people. Environmental security of water everywhere is threatened by pollution from municipal sewage, industrial wastewater and agricultural overflows.

### *Food vs. Water*

Food and water needs conflict in (a) irrigation; (b) meat production; and (c) processed food manufacturing.

(a) Irrigation: use of rainfall and groundwater to irrigate fields where food crops are grown reduces water available for drinking, cooking and washing. Water is needed for irrigation of fields where food crops are grown. Climate change is changing rainfall patterns and quantities all over the world. Let us take Africa as an example. Conway (2009) postulates that Northern and Southern Africa are becoming much hotter and drier, with an impact that wheat production in the north and maize production in the south will be adversely affected. He also predicts that sea levels are rising in the Nile Delta and some parts of West Africa, conquering fields and cities.

In worst hit areas of the world complete lack of rain or constant heavy rains prevent farming altogether. In the benefitting areas reduced or increased precipitation improves farming opportunities. While most plants need water to grow, the bond between food and water is very strong for rice, the most widely eaten basic foodstuff in the world. Rice is usually planted in flooded fields; therefore, if water evaporates or becomes polluted, rice dies. Some plants like durra, on the other hand, are not dependent on water and can thus be cultivated in arid lands.

(b) Meat production: indirect water consumption to grow feed for cattle in sheds or to prepare fields for grazing livestock and direct water usage on farms and ranches reduces water available for drinking, cooking and washing. Meat production consumes more water than corn and vegetable cultivation because of both indirect water consumption to grow feed for cattle in sheds or to prepare fields for grazing livestock and direct water usage on farms and

ranches. Agriculture and raising cattle pollute waterways when fertilizers, pesticides, herbicides and manure flow from fields to brooks, rivers, lakes and seas. Organic farming, subsistence farming and hunting are the least water-intensive food production methods.

(c) Processed food manufacturing: continuous 24/7 processes of food industry also reduce water available for drinking, cooking and washing. Fresh food needs a fraction of water compared to water consumed by processed food. The continuous 24/7 processes of food manufacturing industry consume vast amounts of water. Both the food processing industry and large-scale farming use groundwater sources. In some areas groundwater is a scarce resource; furthermore, in many countries increasingly frequent and prolonged heat waves reduce the level of groundwater. The wells of cities, towns, municipalities, villages, small-scale farmers and families dry up from the combined effect of over-consumption and un-renewability of water resources.

If water is used for producing food for exports, local people may suffer a triple blow: they turn their fields into monoculture, which gradually destroys soil fertility; they have to sell their harvest at dumped export prices to greedy middlemen so that their own families go hungry; and concentrated monoculture farming by all farmers in the area as well as multinational food processing industry established next to the monocultures in low-salary, low health, safety and environmental (HSE) concern areas dry up the groundwater sources so that local people go thirsty. The capitalist solution to these problems is to sell imported foodstuffs and bottled water to the impoverished local inhabitants.

Multinationals also build beverages factories in many dry, population-rich market areas and monopolize all the groundwater, like Coca Cola in Rajasthan, India, resulting in local farmers losing their subsistence crops and local inhabitants losing their drinking water (Woods, 2006). The families start using water from streams polluted by wastewaters from factories.

Post-modern famine caused by mono-crops for exports and death from diarrhea and other diseases caused by polluted drinking and washing water take place publicly among a population of well-nourished and healthy people, not privately in isolated villages.

### *Energy vs. Food*

There are multiple relationships between energy and food: (a) food crops may be burned as bioenergy or refined into biofuels; (b) bio-oils may be refined from plant oils; and (c) biogas energy or biogas fuels may be extracted from field residues, sludge, dung and human excrement.

(a) Field residues, such as straws, have always been used for energy production at farms. Increasingly also food crops are burned as bioenergy or refined into biofuels. In many western developed countries there is overproduction of barley, wheat and maize, which makes it lucrative for farmers to sell their harvest to biofuel refineries. Yet many people and organizations feel that corn should be used for food, not for fuel. The greatest problem arises from developing countries copying the formula. If important food crops like cassava, maize and sweet corn are put into car tanks instead of human mouths, famine becomes a permanent state, instead of a periodical phenomenon, in a large number of developing countries. Local food production by small-scale farmers is essential for the survival of not only families but also communities. Apart from a social issue food for fuel concern is a cultural issue: traditional, ecologically sustainable farming skills will be forgotten, if they are not passed on to the next generation.

(b) In addition to field biomasses, bioliquids are refined from plant oils, such as palm oil, soya oil, rapeseed oil and sunflower oil. Palm oil usage is heavily criticized by environmental and social non-governmental organizations because it causes severe ecological and socio-cultural problems. But as palm oil is used for many purposes also by cosmetics industry and chemicals industry, its biofuel use does not greatly contribute to loss of food. Many other plant oils used for biofuels – soya oil, rapeseed oil and sunflower oil – are more important foodstuffs, particularly since they are essential ingredients of healthy diets. It is recommended

that these oils should replace animal fat in cooking and salads and on bread. That is why using these oils as raw materials for fuels is questionable. Many people think that food should not be used for fuel either in developed or developing countries. On the other hand, animal fat, which is unhealthy to humans, can be used for biofuels. There is a market niche for mass production of biofuels extracted from animal fat. Leftover fat from frying – whether of animal or plant origin – is already a common source of biofuel raw material.

Energy is needed to plough, sow, harvest, transport, and process food. In traditional societies human and animal energy is used for this purpose, but development has meant heavy investments in machinery that use unrenewable oil-based fuels all over the world. The ecological footprint of food production has multiplied because of this “development”. Agricultural machinery use accounts for most of the CO<sub>2</sub> emissions and other pollution from farming. Renewable fuels have been experimented on a small scale at some farms for decades since the farmers have been able to produce their own biofuels. In early 1970s Brazil pioneered at national scale in refining sugarcane into ethanol for both cars and farm machinery, and the programme has been most successful. Since 1976 it has been mandatory to blend ethanol into gasoline in Brazil; in 2009 the minimum was 25 per cent of ethanol, but even 100 per cent is possible. This initiative has boosted innovations in Brazilian agricultural technology and biotechnology, which has benefitted also food production.

Use of sugarcane for biofuel is not opposed much from the no-food-for-fuel point of view because added sugar does not belong to a healthy diet. However, in many countries healthy food plants would be the only economically viable option for large-scale biofuel production.

(c) Instead of food-for-fuel programmes it is possible to develop the production of biogas energy and biogas fuels from field residues, sludge, dung and human excrement. These are the most sustainable biofuel options. However, in the long run the most sustainable options are to produce electricity from the sun, wind and wave energy for both buildings and vehicles. Farming and food production can become simultaneously ecologically, socio-culturally and economically sustainable anywhere in the world through wise, locally specific renewable energy solutions.

### *Water vs. Energy*

The relationship between water and energy is manifold: (a) energy production through hydropower; (b) ways of boiling water; and (c) water used in unrenewable energy production and the hazardous wastewaters such production generates.

(a) One of the oldest forms of renewable energy is hydropower, which has been used for thousands of years in the form of waterwheels and watermills. On a very small scale hydropower does not contribute to climate change. Micro-scale hydropower is an ecologically and socio-culturally sustainable energy production method when it takes advantage of a stream's natural movements to create power and respects local traditions.

Large-scale dams, built to manipulate natural water levels and flow to produce electricity, have major ecological and socio-cultural harmful impacts. Villages and towns have to be removed, which upsets people's lives and livelihoods, destroys communities and leads to the disappearance of cultures and traditions. Damming land areas create artificial lakes. Groundwater sources and cornfields are lost under water. Land sunk into the bottom of the lake emits its heavy metals and other poisonous substances into the water and pollutes the lake so that emerging fish and other marine life either dies or suffers from serious diseases. Storms and other extreme weather conditions, which are becoming more frequent as a result of climate change, as well as earthquakes, can break dams, drowning whole cities for which they have produced electricity. Stagnant water makes plant material decay fast particularly in tropical areas, resulting in major methane and carbon dioxide emissions, thereby contributing to climate change. Water wars may break out when dams have malignant effects on the waterways and lands of neighbouring countries, by diverting water away from their rivers or flooding their fields and population centres.

Power-generating methods that use the natural phenomena occurring in water without disrupting it are usually much more sustainable. These include tidal power, tidal stream power, wave power, osmotic power, marine current power and ocean thermal energy conversion.

(b) Energy is needed among other things to boil water, which makes even somewhat polluted water acceptable for drinking or at least for other household use like washing. Any energy form is suitable for electricity production, but if we think of living conditions of the poor who account for half of mankind, of the renewable energy forms water power is an indirect way of boiling water like wind power while solar and biomass energy are direct methods. Solar power is the least disruptive and energy-consuming way of boiling water.

(c) Many unrenovable power production methods, such as nuclear power plants as well as oil refining and coal production, need large amounts of water in their processes. Their wastewaters are hazardous waste that should be cleaned before discharging, or rather not be discharged at all. Those oil refineries and coal power stations that have adopted the best available technologies (BAT) have closed-loop wastewater treatment processes, which decrease the need to dump wastewater into waterways. Nuclear power plants use huge amounts of water for cooling, and, instead of being used as an energy source the heated water usually ends up in cooling ponds, rivers, lakes, or seas, causing at least ecosystem changes. Mining the raw material, uranium, for nuclear power plants, may also need masses of water, which leads to radioactive wastewater, the treatment of which is expensive and dumping tempting in countries where environmental laws are not enforced effectively. This may result in the radioactive pollution of groundwater.

#### *Food vs. Energy vs. Water*

Food, energy and water issues are interrelated in many ways, and sometimes create a tangle, causing further ecological, social and economic problems. One such example is the case of alga. Exploitation of algae integrates the fulfilment of food, energy and water needs, but causes further ecological, social and economic problems. Naturally growing large algae, i.e. seaweeds are important foodstuffs particularly in Asia, the British Isles, western coast of the USA and New Zealand. In addition, algae can be harvested and used as organic fertilizers on fields. Algae can also be used to capture chemical fertilizers that are flowing from fields to waterways. Moreover, sewage and other wastewater can be treated with algae instead of chemicals or direct discharges into waterways. Plans to refine algae into biofuel are also coming true. Although sewage from cities and wastewaters from industry and agriculture have made the sea and lake conditions favourable for alga growth, which has caused marine life to die for lack of oxygen, biofuel production will require active alga farming to secure constant, even supply of algae. This may cause further lake and sea deaths. Marine biodiversity will be destroyed. Health of local people may suffer. Fishing, tourism and recreation will end. While collecting algae for biofuel extraction cleans up waterways and revives marine life, thus giving the triple benefit for food, energy and water security goals, cultivating algae for biofuel extraction may lead to benefitting energy security goals but impeding water and food security goals. Similar complex interrelations can be detected in most food, energy and water security issues. This is just one example of malignant relationships between food, energy and water.

Figure 1 illustrates the way in which nations can assess their food, energy and water security on scales 1-5 for each of the three variables.

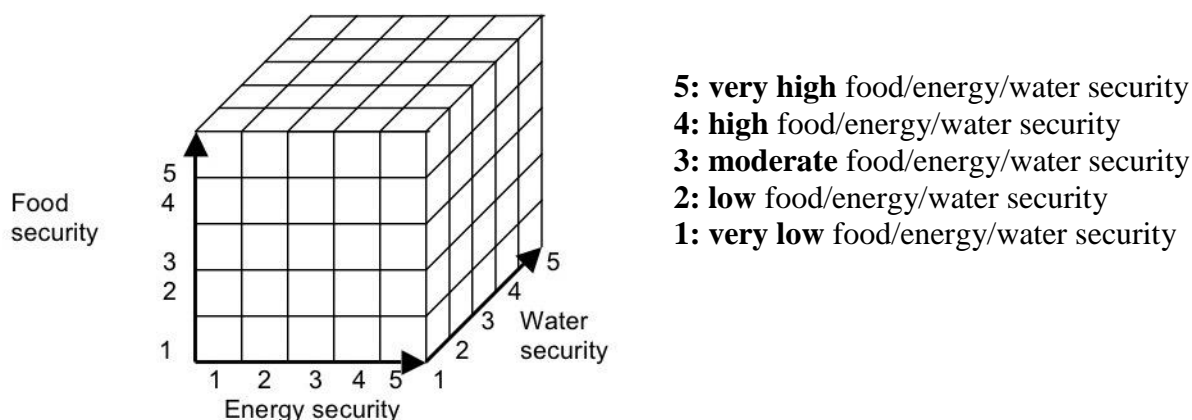


Figure 1. Food, energy and water (FEW) security analysis cube.

The ideal FEW situation is at the top right hand corner of the figure where food, energy and water security are all at levels 5 and the worst situation is in the bottom left hand corner where they are all at level 1. The basic FEW security level criterion is self-sufficiency:

- level 5: very high:  $\geq 100$  % self-sufficiency
- level 4: high: 75-99 % self-sufficiency
- level 3: moderate: 50-74 % self-sufficiency
- level 2: low: 25-49 % self-sufficiency
- level 1: very low:  $< 25$  % self-sufficiency

Self-sufficiency needs to be supplemented by great strengths & potentials for and great problems & threats against food/energy/water (FEW) security. For great strengths & potentials, one level, or even two levels in exceptional situations, can be added. For great problems & threats, one level, or even two levels in exceptional situations, can be subtracted. The measurements for each level need to be tested through cases. The food, energy and water situation of four small countries – my home country Finland and three developing countries of my interest – Bolivia, Bhutan and Botswana – from different continents will be analysed through the FEW security analysis cube.

### Testing the FEW Security Cube in Four Countries

Let us first look at the very basic data on the four case countries (table 1).

Table 1. Some basic information about Finland, Bolivia, Bhutan and Botswana (NationMaster, 2012a, 2012b, 2012c, 2012d, 2012e, 2012f, 2012g, 2012h, 2012i).

	FINLAND	BOLIVIA	BHUTAN	BOTSWANA
POPULATION	5.26 million	10.12 million	0.71 million	2.07 million
TOTAL AREA	338,145 km <sup>2</sup>	1,098,581 km <sup>2</sup>	47,000 km <sup>2</sup>	600,370 km <sup>2</sup>
-Water	10 %	1.29 %	0 %	2.5 %
-Agricultural land	7.55 %	34.00 %	14.64 %	45.62 %
ARABLE CROPLAND	2,191,000 ha	2,206,000 ha	160,000 ha	373,000 ha
-Per capita	0.42 ha	0.22 ha	0.23 ha	0.18 ha
FOOD PRODUCTION INDEX	103.6 %	110.3 %	94.5 %	104.3 %
GDP PER CAPITA (PPP)	\$ 35,9654.77	\$ 4,601.89	\$ 5,067.39	\$ 14,754.75
ELECTRICITY PRODUCTION PER CAPITA	14,702.794 kWh	621.549 kWh	1,922.376 kWh	556.919 kWh
ELECTRICITY CONSUMPTION PER CAPITA	16,850.372 kWh	558.385 kWh	227.163 kWh	1,458.545 kWh

Bolivia is the largest of the four countries both in area and population. Botswana is second in area but Finland in population. In Finland surface water covers a much higher percentage of the land area than in the other three countries. Bolivia and Botswana's actual water surface coverage is just over 40% of Finland's, Bhutan's so minute that it escapes statistics.

In agricultural land percentage of the whole area Finland ranks even lower than Bhutan while Botswana and Bolivia have great areas dedicated to agriculture. However, it is the quality of agricultural land that counts: Finland has twice as much arable cropland per capita as Bolivia, Bhutan and Botswana. The high food production index of all other case countries except Bhutan means that, at least in theory, these countries are self-sufficient in food production, which would suggest that their food security level would be very high – yet there are problems & threats that may reduce food security. Gross domestic product (GDP) per capita, purchasing power parity (PPP) adjusted, gives some idea how well a country could afford to mitigate or solve its food, energy and water problems & threats and take advantage of its strengths & potentials. Finland is a high-income country, Botswana a middle-income country, and Bhutan and Bolivia low-income countries.

Energy security covers both electricity and fuels, but reliable, comparable statistics are available only about electricity. The production and consumption of electricity per capita is the highest in Finland, which is 87.5% self-sufficient and needs to import 12.5% of its electricity. Bhutan produces the second largest amount of electricity of the four case countries but consumes least of all these countries, leading it to a tremendous 845% self-sufficiency in theory. Bolivia produces slightly more electricity than it consumes, making it 111% self-sufficient in theory. Botswana is only 38% self-sufficient in electricity production.

The numbers may be misleading because there are many strengths & potentials as well as problems & threats that they do not take into account. The following, more detailed descriptions of food, energy and water (FEW) security and their interrelations of the four countries will pay special attention to these intervening factors.

### *Finland*

Food: F4: Finland is self-sufficient in food production with enough good arable land for farming, green pastures for grazing and well-developed food production industry. Finland produces a good variety of food, securing a nutritious, balanced diet. The country could feed its current population without imports. It could replace imports with domestic substitutes. Finland is dependent on fertilizers but organic food production is increasing. Finland ranked the least food security risk country in the world in 2010 (Maplecroft, 2010). Climate change may have both positive impacts (more temperate climate would enable wider variety of crops and several harvests a year) and negative impacts (warmer climate would invite more different kinds of pests) on Finland's food security. Climate change refugees could add mouths to feed, but since Finland is the furthest country up north in its longitude, the refugees from Africa will populate first Southern Europe, wander then to Central Europe, and of the Northern European countries probably try Denmark and Sweden, which are accessible by road, before taking a ferry to Finland.

Energy: E2->3: Currently Finland imports 70% of the energy it needs. Most of it, 45%, comes from Russia as unsustainable, unrenewable oil, gas and coal. Domestic energy production includes wood 22%, nuclear 18%, peat 6% and hydro & wind 3% (Statistics Finland, 2012). In electricity production Finland is 83.6% self-sufficient (Finnish Energy Industries, 2011). There are 200 hydropower plants in Finland; the largest is 170 MW, others much smaller, all totalling nearly 3,000 MW. It is not really possible to build more hydropower in Finland without damaging the environment. According to the government's energy plan (Finnish Government, 2010) Finland aims to reduce carbon dioxide emissions by 20% from the 1990 level and become almost self-sufficient by 2020 by adding nuclear power and renewable energy production. The nuclear energy share should thus gradually increase even to 62% with the fifth nuclear power plant currently under construction and two or three more nuclear power plants being planned. The building of nuclear power plants 1-5 was given



to French and German companies, which subcontracted work mostly to other foreign companies with foreign workers. The share of renewables is planned to reach 38% of total energy production by adding wood, biofuel, wind and geothermal energy (Finnish Government, 2010).

Water: W5: Finland is totally self-sufficient in water supply: it has very good rainfall, groundwater all over its land area as well as 187,888 lakes, 647 rivers and 314,000 km of shoreline (Finnish Water Forum, 2012b). The country borders to seas in the south and west, but seawater is not needed for households or agricultural irrigation. 46% of drinking water is groundwater, 19% artificial groundwater and 35% surface water (Finnish Water Forum, 2012b). Algae overgrowth caused by eutrophia is an increasing problem in the surface waters of seas, lakes and rivers. Finland is an expert in water security issues and promotes them through its development cooperation projects (Finnish Water Forum, 2012a).

Positive FEW interrelations: Algae collection for biofuels from lakes, rivers and seas could clean waters; algae could also be used for food, but that is not traditional in Finland. Climate change with a more temperate climate and increased precipitation may improve food and water security, unless heat waves make soil too hard to absorb the rainwater, which turns rains into floods and leads to soil erosion.

Negative FEW interrelations: A nuclear power plant disaster would lead to food, energy and water crises because of radiation and great dependence on nuclear. Big increase in wood-based energy may reduce forests, lead to soil erosion, and result in food and water crises. Biofuel production may mean sacrificing others' forests for fuel (destroying rainforests for palm oil plantations) or own food for fuel (growing e.g. rape seed oil for biofuels rather than food oil).

### *Bolivia*

Food: F2: In Bolivia food production is based on subsistence agriculture. The country produces a good variety of food because of various climates, but not sufficiently. Only 2% of land area is in arable farming. Bolivia suffers from extremely low productivity, poor distribution of the population in relation to productive land and lack of transportation facilities. Additionally, as poverty in remote areas amounts to 83%, most of the citizens have difficult geographical and financial access to food (WFP, 2012a). Constant natural disasters, such as floods, mudslides, landslides and droughts, cause crop loss (FAO/WFP, 2008; WFP, 2012b). Malnutrition is common in rural areas where up to 40% of small children suffer from it; national prevalence is 27% (WFP, 2012a). Bolivia is the only country in South America rated as a high food security risk country (Maplecroft, 2010). Bolivia exports soybean on the Andean Community market (FAO, 2007). The country develops food production through irrigated agriculture, which has malignant impacts on the environment. More environmentally benign ways of achieving food security and diversification of crops would be crop rotation and planting of nitrogen fixing legumes, which improve soil without irrigation or fertilizers.

Energy: E3: In theory Bolivia has full self-sufficiency in energy supply. In gas reserves Bolivia ranks 30<sup>th</sup> and in oil reserves 50<sup>th</sup> in the world (Wikipedia 2012a, 2012b). It exports oil and, particularly, gas to Brazil, which brings revenues for Bolivia's development. Bolivia is a land-locked country and needs Brazil's pipelines to export its hydrocarbons. Brazil plans to increase its own hydrocarbon production so that it would not need any imports. Other export opportunities are dwarfed by the neighbouring countries' doubts of the ability of Bolivia's national energy company, YPFB, to maintain continuous energy supply and by Argentina's and Chile's own hydrocarbon development plans (Romero & Schipani, 2010). Bolivia has made investment alliances with Russian and Chinese oil and gas companies (Schipani, 2010).

In electricity production Bolivia is 111% self-sufficient due to hydropower plants. However, because of huge distances in varied terrains and poverty many Bolivians have difficult geographical and financial access to energy, which means that the nation cannot supply energy to all its citizens. Gas and oil production was re-nationalized in 2006 by

Bolivia's first indigenous president, Evo Morales, and on Labour Day, 1 May 2010, he nationalized also four hydroelectric companies (Ore & Garcia, 2010). The long-term aim of nationalization is to provide all Bolivians with electricity. The re-nationalization of gas and oil in 2006 did not much ease the fulfilment of energy needs of ordinary Bolivians although some of the revenues have been invested in the socio-economic development of the lives of indigenous peoples.

Water: W2: Bolivia suffers from economic water scarcity (Molden, 2007). The eastern tropical and subtropical areas of Bolivia and lake Titicaca basin are self-sufficient in water supply, but western semiarid and arid areas are not. One third of the city dwellers and half of rural people have no access to water. Water supply was privatized in arid Cochabamba in 2000 and in La Paz/El Alto in 2005, which led to triple prices and violent protests, resulting in re-nationalization (Hailu *et al.*, 2010). Access and maintenance problems continue. Water quality is constantly decreasing because of the dumping of untreated effluents from industries, cities and irrigated agriculture into water sources. Irrigation accounts for 94% of all water withdrawals (Giugale *et al.*, 2006) and its needs threaten drinking water supplies. Rapid melting of glaciers is causing water shortages (Rosenthal, 2009). Chacaltaya glacier near La Paz/El Alto has already melted and emptied the water supplies of that area during the dry season (Painter, 2009). Disappearance of glaciers makes Bolivia more dependent on rainfall, which, in turn, has become more erratic.

Positive FEW interrelations: Substance farming has minor impact on water quantity and quality and it could be developed organic. There are solar, wind, wave and biomass energy potentials for food and water production.

Negative FEW interrelations: Irrigated agriculture has led to soil erosion and loss of production capacity of 41% of land area. Agricultural runoff is one of the main contributors to water pollution. Slash-and-burn farming reduces forests, leads to soil erosion and exhaustion of its nutrients, resulting in food and water crises. Amazon basin (66% of Bolivia) is prone to floods, causing crop loss. Constant natural disasters caused by El Niño and La Niña, accelerated by climate change, lead to food, energy and water crises. Major oil and gas production pollute soil and water and increase CO<sub>2</sub> emissions. Melting of glaciers cause drinking, irrigation and hydropower water shortages.

### *Bhutan*

Food: F2: Food production in Bhutan is based on subsistence farming and animal husbandry. Subsistence agriculture employs 70% of the population, and due to the rugged terrain, almost all arable land is already under cultivation (Gross National Happiness Commission, 2011). One third of the Bhutanese suffer from food insecurity (WFP, 2012c) and every third child is chronically malnourished (Gross National Happiness Commission, 2011). Nevertheless, Maplecroft (2010) rates Bhutan as a medium food security risk country. Bhutan imports 34% of its cereal needs (WFP, 2012c), e.g. over 40% of the staple rice from India (WFP, 2012d). In January 2010 the first ever rice mill in Bhutan started operating in Chuzagang, Sarpang, in southern Bhutan (Bhutan Today, 2010). Southern subtropical plains and temperate central highlands could become self-sufficient in food production, northern polar-type Himalaya cannot. Yet it is the eastern and southern regions that are most vulnerable to food insecurity (WFP, 2012c). Natural disasters in rainy seasons cut off access to non-local food supplies and destroy local supplies. The government attempts to reverse the declining trend in cereal yield per hectare and per capita food production by education, zoning the country's territory and delineating protected areas for agricultural production. Instead of maximizing gross domestic product (GDP), Bhutan aims to maximize Gross National Happiness (GNH), an indicator of the quality of life, which takes account of equitable and sustainable socio-economic development, conservation of the natural environment, preservation and promotion of traditional culture, development of good governance, and the satisfaction and spiritual growth derived from them (Ketola, 2010).

Energy: E4: Bhutan is a land-locked country with rugged terrains, which make energy

production and supply to the citizens difficult. However, the country's rapid altitudinal variations and swift flowing rivers make it perfect for hydropower (Tshering & Tamang, 2004). Bhutan is 845% self-sufficient in electricity due to the gigantic Tala Hydroelectricity dam project; all the dam's electricity is exported to India. Of all power generated in Bhutan 80% is exported to India (ADB, 2008). This brings good revenues to the country. There are more than 20 other hydro dams that supply electricity to the Bhutanese. Further hydropower potential amounts to 30,000 MW. About 97% of commercial activities use hydro electricity. Electrification of household has intensified during the 2000s: by 2011 electricity was provided to 60% of rural households, and 84% was the target for 2012 (Chhetri, 2011). However, most households with access to electricity use it only for lighting, and use firewood for heating and cooking. Bhutan is the highest firewood user per capita in the world (Pelden, 2010b). The government's attempts to replace firewood with cow dung biogas include a five-year trial program in four districts during 2011–2015 (Pelden, 2010b). The Bhutanese government aims to expand domestic electricity network so that by 2020 the entire country would have access to electricity and the domestic tariff would be kept low enough for citizens to be able to afford to buy electricity (Tshering & Tamang, 2004). Hydropower should enhance Bhutan's sustainable development in two ways: (a) it provides clean, renewable, safe, reliable, sufficient and affordable electricity for domestic consumption and industrial use, and (b) it brings the much needed capital to finance social projects and achieve economic self reliance (Tshering & Tamang, 2004). The environmental and social problems caused by water diversion and damming – e.g. population displacement, intrusion into protected areas, loss of primary forests, dewatering impacts, soil erosion and fish migration (Tshering & Tamang, 2004) – need to be addressed better than before. Gross National Happiness (GNH) index protects forests of central highlands from overuse for energy. Bhutan imports all the fuel it needs. There is great solar energy potential in Bhutan. As a result of climate change, water supply for hydropower is vulnerable; hence solar and windmill projects have started (Pelden, 2010c). The Bhutan Power Corporation has provided solar electrification training for villagers of eight districts in rural eastern Bhutan (Pelden, 2010a). In 2010 the Asian Development Bank gave Bhutan a grant of \$21.6 million for on-grid-electrification, solar power, wind power and cattle dung biogas projects (Chhetri, 2010).

Water: W3: The so far abundant water supply of the main rivers flowing through highlands, where most Bhutanese live, depend on Himalayan glaciers. Climate change has accelerated their shrinking and made glacial lakes liable to outbursts (Gross National Happiness Commission, 2011), which will first flood the valleys and then result in water shortage. Hydropower takes huge amounts of water from other needs, such as rice fields, growing industry, domestic use and increasing urbanization (Bhutan, 2003). Even current drinking water security suffers from poor management. Bhutan's rural water supply scheme (RWSS) from 1974 should provide 89% coverage of drinking water, but only about 36% work without problems due drying water sources, traditional water rights, damaged pipes and structures, lack of regular maintenance, inadequate community maintenance and lack of trained water caretakers and tools (Lamsang & Wangdi, 2009). Moreover, differences in rainfall patterns and increasing fluctuation between lean season and monsoon season water flows cause localized and seasonal water shortages. The International Water Management Institute estimates Bhutan to suffer from economic water scarcity (Molden, 2007).

Positive FEW interrelations: Vast river areas allow food, energy and water co-production. Small population helps to increase food, energy and water security at low cost.

Negative FEW interrelations: Climate change has manifold effects: melting of Himalayan glaciers will make Bhutan more dependent on rainfall, which, in turn, may become more erratic with flash floods and draughts adversely impacting food, energy and water security. Hydropower dams sink fields and cause water and soil pollution. Floods and landslides resulting from hydropower and increasingly heavy monsoons lead to soil erosion and loss of arable farmland. Increasingly drier lean seasons have the same effects.

## *Botswana*

Food: F3->2: Botswana's climate is arid and semiarid with low rainfall (Botswana, 2008). Kalahari Desert covers nearly 70% of the country. Increasing droughts cause water shortages and spread desertification, shrinking arable land further. Less than 5% of agricultural irrigation can come from rainfall (Darkoh, 2003), making agriculture unprofitable. Hence 50% of Botswana households raise cattle and livestock, needing grazing lands, which accelerates desertification (Darkoh, 2003). Domestic production can supply only 10 % of the cereal needs, and nearly all the annual cereal requirement is imported (Botswana, 2008). About 25% of population is undernourished. Although this is less than in Sub-Saharan Africa in general, improvement of food security is one of the main objectives of the Botswana government (Botswana, 2008). Nonetheless, Maplecroft (2010) rates Botswana only as a medium food security risk country. Botswana has diamonds and other minerals to buy food from abroad, so it is dependent on other countries and has not become self-sufficient in food production. However, the country plans to become less dependent on diamonds and diversify its agricultural basis dominated by cattle farming, thereby trying improve its food security and employment (Government of Botswana, 2009).

Energy: E2: Botswana is only 38% self-sufficient in electricity, which comes from two coal power stations, and imports the rest, mainly from South Africa. Electricity is available predominantly only in urban areas, and the government supports rural electrification (Botswana, 2008). Botswana imports all the fuel it needs, mostly from South Africa. The country has tiny oil reserves, which are not yet exploited. Botswana's vast national parks and game reserves are protected from forest cutting e.g. for fuelwood. With 3,200 hours of sunshine a year the country has enormous solar energy potential, which the government programmes support (Botswana, 2008) and which could in the long term make Botswana self-sufficient in electricity production.

Water: W1: Botswana suffers from physical water scarcity (Molden, 2007). Botswana's water shortage is very serious and continues to get worse because of accelerating droughts and desertification. The Okavango, Limpopo, Zambezi and Orange Rivers are shared by and get their waters from neighbouring countries, and are shrinking mainly due to droughts but also because of dams. This may cause water conflicts between the nations. Botswana does not produce hydropower but suffers from effects of hydro-production of the neighbouring countries. The dams on rivers in Botswana have been constructed for livestock watering and urban water supply (Botswana, 2008). Lack of seasonal rainfall in Botswana results in 75% of humans and animals dependent on groundwater. Surface water is very scarce. Yet, by 2001 nearly 98% of Botswana had some access to drinking water, and the government is committed providing clean, reliable, affordable water supply to all citizens by 2016 (Government of Botswana, 2009).

Positive FEW interrelations: Botswana's Department of Forestry and Range Resources reintroduces indigenous vegetation, which aims to mitigate land degradation, thereby helping food production and water conservation (Mogotsi *et al.*, 2006). The HIV/AIDS has left the younger generation without knowledge and practises usually passed on from the older generation. The United Nations Development Programme (UNDP) works with Botswana communities, re-introducing indigenous knowledge and traditional land management systems (Afrol News, 2004), thereby enhancing food and water security. The National Development Plan 2009–2015 identifies four fundamental areas that will enable Botswana to attain universal social wellbeing for all by year 2016: poverty alleviation, access to good quality health facilities, good quality sanitation and an adequate supply of safe water (Government of Botswana, 2009) – the first area relates to food and the third and fourth relate to water.

Negative FEW interrelations: Climate change accelerates droughts and desertification leading to food and water crises. Drilling deep boreholes for groundwater leads to soil erosion and consequently to even less arable land (Darkoh, 2003). The Okavango Delta is drying up because of overgrazing (Botswana, 2008).

### Discussion: FEW security of the four nations

The findings of these brief food, energy and water (FEW) security analyses of the four case countries, Finland, Bolivia, Bhutan and Botswana, are illustrated by the FEW cube in figure 2.

According to these concise analyses taking account of self-sufficiency as well as great strengths & potentials and great problems & threats, the food, energy and water (FEW) security findings are as follows. *Finland's* (FEW) security is F4–E2–>3–W5, meaning that food security is high, energy security is rising from low to moderate and water security is very high. *Bolivia's* FEW security is F2–E3–W2, meaning that food security is low, energy security is moderate and water security is low. *Bhutan's* FEW security is F2–E4–W3, meaning that food security is low, energy security is high and water security is moderate. *Botswana's* FEW security is F3->2–E2–W1, meaning that food security is decreasing from moderate to low, energy security is low and water security is very low.

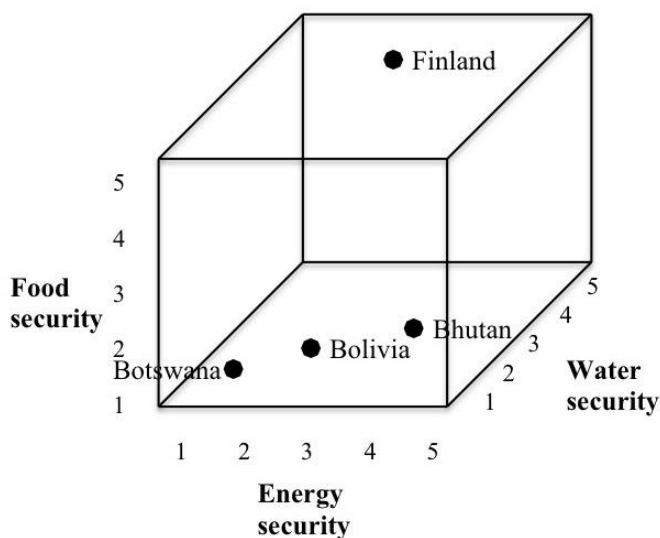


Figure 2. Four countries in the food, energy and water (FEW) security analysis cube.

In *food security* Bolivia, Bhutan and Botswana are weak and need considerable improvements. In *energy security* Botswana is weak but the others manage quite well – if only Bolivia and Bhutan managed to get electricity to all rural areas in one way or another; grid-free solar energy could solve the problem for all three countries. In *water security* Botswana is on the brink of disaster, and Bolivia is weak, needing major improvements. All in all, the most serious FEW problems lie in Botswana because of the downward spiral that anthropogenic climate change and its consequences are causing in the interrelations between food, energy and water, but Botswana has more financial resources to overcome its problems than Bolivia and Bhutan.

The United Nations World Food Programme (WFP) operates in the most *food* insecure countries, including two of the case countries, Bolivia and Bhutan. Although Botswana has the worst prospects for food self-sufficiency, it is a middle-income country that can afford to buy all it needs to secure the food supply of its 2.07 million citizens. However, the United Nations Development Programme (UNDP) helps Botswana in its severe *water* security problems, which are closely connected to food security problems.

Bolivia, Bhutan and Botswana are land-locked countries, which impedes their ability to be independent in their *energy* sales and purchases. This problem should encourage them to distribute their existing energy domestically among their citizens and develop local renewable energy forms, such as solar, wind and biomass production, which they do to some extent, but also crave for revenues from exports. Seafaring Finland still imports most of its energy in oil tankers and coal ships, but plans to increase some renewable energy production in addition to building more nuclear plants. The governments of all four nations seem to ignore the most

environmentally, socio-culturally and economically sustainable energy resource: organic waste. Human excrement, animal dung and organic waste streams from industry are infinite energy sources. Making bioenergy out of organic waste would additionally solve the over-fertilization of waterways causing sea, lake and river deaths.

Wealthy Finland wastes some of its abundant food, energy and water resources; hence it could be called Binland. The other B-countries, Bolivia, Bhutan and Botswana, could not really afford to waste any of their resources.

## Conclusions

This research paper developed a food, energy and water (FEW) security model, so that nations could evaluate their current state and future developmental needs of FEW security based on globally sustainable development. The FEW model integrates quantitative data on self-sufficiency into qualitative information about the great strengths & potentials and great problems & threats in each issue, and takes account of the interrelations between the food, energy and water issues.

The four case studies show that analyses through the FEW model help to see the whole picture without getting lost in the details. The model needs further refining in taking simultaneously the environmental, socio-cultural and economic dimensions of sustainability into account, but seems to be practicable as a simple tool to filter masses of quantitative and qualitative information into guiding food, energy and water security levels.

This research paper studied only the first level of Maslow's hierarchy of needs: physiological needs. The first part of my argument that Finland emphasizes the maximum fulfilment of physiological and safety needs, Botswana social needs, Bolivia esteem needs, and Bhutan self-actualization and self-transcendence needs, coincides with the findings that Finland rates best in the FEW security cube. Meeting the basic food, energy and water needs of citizens is naturally crucial for all nations, but wellbeing covers more than that. The subsequent papers will analyze the fulfilment of the other five Maslow's needs groups – safety, social, esteem, self-actualization and self-transcendence needs – in Finland, Bolivia, Bhutan and Botswana, and make comparisons between the needs groups of the case countries.

## References

- ADB 2008. *Proposed Loans, Asian Development Fund Grant, Technical Assistance Grant, and Administration of Grant – Bhutan: Green Power Development Project*. Asian Development Bank: Manila. <http://www2.adb.org/Documents/RFPs/BHU/37399-BHU-RRP.pdf> retrieved 30 April 2012.
- Afrol News 2004. Botswana villages fighting desertification. *Afrol News*, 3 June 2004. <http://www.afrol.com/articles/13090> retrieved 30 April 2012.
- Bhutan 2003. *Bhutan Water Policy*. Royal Government of Bhutan and Bhutan Water Partnership: Thimphu. [http://www.moaf.gov.bt/moaf/?wpfb\\_dl=149](http://www.moaf.gov.bt/moaf/?wpfb_dl=149) retrieved 11 May 2012.
- Bhutan Today 2010. First ever rice mill to aid food security in Bhutan. *Bhutan Today*, January 8, 2010.
- Botswana 2008. National Investment Brief – Botswana. *High-Level Conference on: Water for Agriculture and Energy in Africa: The Challenges of Climate Change*. Sirte, Libyan Arab Jamahiriya, 15–17 December 2008.
- Chhetri P 2010. ADB grants \$ 21.6 m for rural electrification. *Bhutan Observer*, November 10. <http://www.bhutanobserver.bt/adb-grants-21-6-m-for-rural-electrification/> retrieved 11 May 2012.
- Conway G 2009. The science of climate change in Africa: impacts and adaptation. *Grantham Institute for Climate Change, Discussion paper No 1*, October, Imperial College, London.
- Darkoh MBK 2003. The Nature, Causes and Consequences of Desertification in the Drylands of Africa. In Darkoh, Michael B.K. – Rwomire, Apollo (2003) (eds.) *Human Impact on Environment and Sustainable Development in Africa*, 199-236. Ashgate, Aldershot.



- FAO 2003. *Trade Reforms and Food Security: Conceptualizing the Linkages*. Food and Agriculture Organization of the United Nations: Rome.
- FAO 2007. *Future Expansion of Soybean 2005–2014. Implications for Food Security, Sustainable Rural Development and Agricultural Policies in the Countries of Mercosur and Bolivia*. Food and Agriculture Organization of the United Nations: Santiago.
- FAO/WFP 2008. *Special Report FAO/WFP Food Security Assessment Mission to Bolivia*, 28 May. <http://www.fao.org/docrep/010/ai467e/ai467e00.htm> retrieved 30 April 2012.
- Finnish Energy Industries 2011. Energy sources (in Finnish). <http://www.energia.fi/energia-ja-ymparisto/energialahteet> retrieved 30 April 2012.
- Finnish Government 2010. *Government Decides on Policies for Nuclear Power and Promotion of Renewable Energy Production*. Ministry of Employment and the Economy, 21.4. <http://valtioneuvosto.fi/ajankohtaista/tiedotteet/tiedote/en.jsp?oid=293158> retrieved 30 April 2012.
- Finnish Water Forum 2012a. Towards water security. <http://www.finnishwaterforum.fi/en/home/finnish+water/peace+and+social+development/water+security/> retrieved 11 May 2012.
- Finnish Water Forum 2012b. Water supply in Finland. <http://www.finnishwaterforum.fi/binary/file/-/id/15/fid/167/> retrieved 11 May 2012.
- Giugale MM, Luff C, Fretes-Ciblis V (eds.) 2006. *Bolivia – Public Policy Options for the Well-being of All*. The International Bank for Reconstruction/World Bank: Washington DC.
- Government of Botswana 2009. *The National Development Plan 10*. Ministry of Finance and Development Planning: Gaborone.
- Gross National Happiness Commission 2011. *Bhutan National Human Development Report 2011: Sustaining Progress: Rising to the Climate Challenge*.
- Hailu D, Osorio R, Tsukada R 2009. *Privatization and Renationalization: What went Wrong in Bolivia's Water Sector?* International Policy Centre for Inclusive Growth (IPC-IG). <http://www.inesad.edu.bo/bcde2009/A3%20Hailu%20Osorio%20Tsukada.pdf> retrieved 30 April 2012.
- Kaiser Family Foundation 2008. *The HIV/AIDS Epidemic in South Africa*, October. The Henry J. Kaiser Family Foundation: Menlo Park, CA. <http://www.kff.org/hivaids/upload/7365-065.pdf> retrieved 30 April 2012.
- Ketola T 2010 Responsible leadership: building blocks of individual, organizational and societal behaviour. *Corporate Social Responsibility and Environmental Management*, 17(3): 173–184.
- Kropp R 2009. Global water resources threatened by climate change and population growth. *Sustainability Investment News*, March 5, 2009.
- Lamsang T, Wangdi N 2009. Water shortage problem hits (PM's) home. *Kuensel Online*, 11 April. <http://www.kuenselonline.com/modules.php?name=News&file=article&sid=12262> retrieved 30 April 2012.
- Maplecroft 2010. African nations dominate Maplecroft's new Food Security Risk Index - China and Russia will face challenges. <http://maplecroft.com/about/news/food-security.html> retrieved 30 April 2012.
- Maslow A 1943. *Psychology of Science*, Gateway Publishers: Chicago.
- Mogotsi KK, Kanego A, Sebele N, Kgaswane M, Gabaitse H 2006. New opportunities for combating desertification in Botswana: Women in action for sustainable land and natural resources management. <http://www.iydd.org/documents/NOTCDIB.pdf> retrieved 30 April 2012.
- Molden D 2007. *Water for Food, Water for Life: A Comprehensive Assessment of Water Management*. Earthscan: London & International Water Management Institute: Colombo.
- NationMaster 2012a. *People Statistics: Population (most recent) by country*. [http://www.nationmaster.com/graph/peo\\_pop-people-population](http://www.nationmaster.com/graph/peo_pop-people-population) retrieved 30 April 2012.

- NationMaster 2012b. *Geography Statistics: Area: Total (most recent) by country*. [http://www.nationmaster.com/graph/geo\\_are\\_tot-geography-area-total](http://www.nationmaster.com/graph/geo_are_tot-geography-area-total) retrieved 30 April 2012.
- NationMaster 2012c. *Geography Statistics: Area: Water (most recent) by country*. [http://www.nationmaster.com/graph/geo\\_are\\_wat-geography-area-water](http://www.nationmaster.com/graph/geo_are_wat-geography-area-water) retrieved 30 April 2012.
- NationMaster 2012d. *Agriculture Statistics: Agricultural land: % of land area (most recent) by country*. [http://www.nationmaster.com/graph/agr\\_agr\\_lan\\_of\\_lan\\_are-agriculture-agricultural-land-of-area](http://www.nationmaster.com/graph/agr_agr_lan_of_lan_are-agriculture-agricultural-land-of-area) retrieved 30 April 2012.
- NationMaster 2012e. *Agriculture Statistics: Arable and permanent cropland (most recent) by country*. [http://www.nationmaster.com/graph/agr\\_ara\\_and\\_per\\_cro-agriculture-arable-and-permanent-cropland](http://www.nationmaster.com/graph/agr_ara_and_per_cro-agriculture-arable-and-permanent-cropland) retrieved 30 April 2012.
- NationMaster 2012f. *Agriculture Statistics: Food production index (most recent) by country*. [http://www.nationmaster.com/graph/agr\\_foo\\_pro\\_ind-agriculture-food-production-index](http://www.nationmaster.com/graph/agr_foo_pro_ind-agriculture-food-production-index) retrieved 30 April 2012.
- NationMaster 2012g. *Economy Statistics: GDP (most recent) by country*. [http://www.nationmaster.com/graph/eco\\_gdp-economy-gdp](http://www.nationmaster.com/graph/eco_gdp-economy-gdp) retrieved 30 April 2012.
- NationMaster 2012h. *Energy Statistics: Electricity: Production (per capita) (most recent) by country*. [http://www.nationmaster.com/graph/ene\\_ele\\_pro\\_percap-energy-electricity-production-per-capita](http://www.nationmaster.com/graph/ene_ele_pro_percap-energy-electricity-production-per-capita) retrieved 30 April 2012.
- NationMaster 2012i. *Energy Statistics: Electricity: Consumption (per capita) (most recent) by country*. [http://www.nationmaster.com/graph/ene\\_ele\\_con\\_percap-energy-electricity-consumption-per-capita](http://www.nationmaster.com/graph/ene_ele_con_percap-energy-electricity-consumption-per-capita) retrieved 30 April 2012.
- Ore D, Garcia E 2010. Bolivia nationalizes four power companies. *Reuters*, 1 May 2010. <http://www.reuters.com/article/idUSTRE64013020100501> retrieved 1 May 2012.
- Painter J 2009. Huge Bolivian glacier disappears. *BBC News*, 12 May. <http://news.bbc.co.uk/2/hi/americas/8046540.stm> retrieved 12 May 2012.
- Pelden S 2010a. 21 villagers trained to light homes. *Bhutan Observer*, January 2. <http://www.bhutanobserver.bt/21-villagers-trained-to-light-homes/> retrieved 11 May 2012.
- Pelden S 2010b. From dung to clean energy. *Bhutan Observer*, August 31. <http://www.bhutanobserver.bt/from-dung-to-clean-energy/> retrieved 11 May 2012.
- Pelden S 2010c. Looking beyond hydropower. *Bhutan Observer*, April 2. <http://www.bhutanobserver.bt/looking-beyond-hydropower/> retrieved 11 May 2012.
- Romero S, Schipani A 2010. Neighbors challenge energy aims in Bolivia. *The New York Times*, January 9. <http://www.nytimes.com/2010/01/10/world/americas/10bolivia.html> retrieved 30 April 2012.
- Rosenthal E 2009. In Bolivia, water and ice tell of climate change. *The New York Times*, December 13. <http://www.nytimes.com/2009/12/14/science/earth/14bolivia.html?pagewanted=all> retrieved 11 May 2012.
- Schipani A 2010. Bolivia launches ambitious energy plans. *Financial Times*, August 26. <http://www.ft.com/intl/cms/s/0/fc451fa2-b11e-11df-bce8-00144feabdc0.html#axzz1ubRHPW1z> retrieved 11 May 2012.
- Statistics Finland 2012. Energy supply and consumption. *Official Statistics of Finland*. [http://www.stat.fi/til/ehk/2011/04/ehk\\_2011\\_04\\_2012-03-22\\_en.pdf](http://www.stat.fi/til/ehk/2011/04/ehk_2011_04_2012-03-22_en.pdf) retrieved 11 May 2012.
- Tshering S, Tamang B 2004. Hydropower – Key to sustainable, socio-economic development of Bhutan. *United Nations Symposium on Hydropower and Sustainable Development*, Beijing, China, 27–29 October 2004.
- von Braun J, Meinzen-Dick R 2009. “Land grabbing” by foreign investors in developing countries: risks and opportunities. *IFPRI Policy Brief* 13, April, International Food Policy Research Institute, Washington, DC.
- WFP 2012a. *World Food Program: Countries: Bolivia*. <http://www.wfp.org/countries/bolivia> retrieved 30 April 2012.



- WFP 2012b. *Operations: Recovery of Food-Insecure Households Affected by Consecutive Natural Disasters*. <http://www.wfp.org/content/recovery-food-insecure-households-affected-consecutive-natural-disasters> retrieved 30 April 2012.
- WFP 2012c. *World Food Program: Countries: Bhutan*. <http://www.wfp.org/countries/bhutan> retrieved 30 April 2012.
- WFP 2012d. *World Food Program: Bhutan: Food Markets*. <http://www.foodsecurityatlas.org/btn/country/availability/food-markets> retrieved 30 April 2012.
- WHO 2006a. *Mortality Country Fact Sheet 2006. Swaziland*, World Health Organization: Geneva. [http://www.who.int/whosis/mort/profiles/mort\\_afro\\_swz\\_swaziland.pdf](http://www.who.int/whosis/mort/profiles/mort_afro_swz_swaziland.pdf) retrieved 28 November 2009.
- WHO 2006b. *Country Health System Fact Sheet 2006. Botswana*. World Health Organization: Geneva. [http://www.afro.who.int/home/countries/fact\\_sheets/botswana.pdf](http://www.afro.who.int/home/countries/fact_sheets/botswana.pdf) retrieved 28 November 2009.
- Wikipedia 2012a. *List of countries by natural gas proven reserves*. [http://en.wikipedia.org/wiki/List\\_of\\_countries\\_by\\_natural\\_gas\\_proven\\_reserves](http://en.wikipedia.org/wiki/List_of_countries_by_natural_gas_proven_reserves) retrieved 30 April 2012.
- Wikipedia 2012b. *List of countries by proven oil reserves*. [http://en.wikipedia.org/wiki/List\\_of\\_countries\\_by\\_proven\\_oil\\_reserves](http://en.wikipedia.org/wiki/List_of_countries_by_proven_oil_reserves) retrieved 30 April 2012.
- Woods, B. 2006. *A World Without Water*, Documentary. True Vision Productions: London.

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**Ecological Modernization and Pesticides in Oman**

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**Extended Abstract**

Although during the last two decades Oman has experienced rapid economic development, this has been accompanied by the emergence of a number of environmental problems. Manufacturing and agricultural output have increased substantially, but this was not initially balanced with sufficient environmental management. Positive impacts of this development have included higher Gross Domestic Product (GDP) per capita, better infrastructure and higher standards of living.

Although agriculture in Oman is not usually considered a major component of the economy, government policy has been directed towards diversification of national income away from hydrocarbon and as a result there has been an increasing emphasis on revenue from agriculture and an enhancement of production via the use of irrigation, machinery and inputs such as pesticides. In recent years this has been tempered with a range of interventions to encourage more sustainable production. Certain pesticides have been prohibited; there has been a promotion of organic agriculture and an emphasis on education and awareness programs for farmers. The last point is of especial relevance given the nature of the farm

labour market in Oman and a reliance on an expatriate and often untrained workforce. Given the centralised nature of the government in Oman, it provides a unique set of insights into the processes of putting sustainable agriculture into practice and the factors that may work against this.

This study explores the changes in the agricultural sector in Oman through the lens of Ecological Modernisation (EM) theory. Various studies on the actors, mechanisms and dynamics in shaping environmental management and (improved) environmental performance have been brought together under EM as an overarching theoretical framework. EM primarily aims to explain and understand the main mechanisms and dynamics in environmental reforms of production and consumption practices. Given their significant impact on production as well as the environment and human health, the primary focus of the research was the use and abuse of pesticides. The study draws out the process by which agricultural policy is developed by the upper levels of the government executive within a centralised system, including support for international agreements and protocols, and the mechanisms by which these policies are implemented and how impact is perceived at the farm level especially in relation to pesticide use and pesticides safety. The fieldwork of this research comprises interlinked consecutive phases. Semi-structured interviews with seventeen key respondents from governmental and non-governmental organisations took place between September 2011 and January 2012. The questionnaires were developed in English and translated into Arabic for some respondents. The selection of individuals for interview was pivotal and therefore national senior managers and government officials were chosen. The responses obtained provided greater understanding of existing issues at the agriculture - environment interface in Oman. Each interview was transcribed to ensure that all the relevant information was captured. Data collection from interviews involved identifying principal study themes. Thirteen of the 17 respondents had agricultural backgrounds; the four remaining represented the Health, Environment, Finance and ENGO sectors.

Based on prior research and study of environmental and agricultural policies and their implementation in Oman, six key issues were identified as affecting the development of agriculture and the environment in Oman:

1. Al-Batinah is the major farming area in Oman.
2. Problems with pesticides and the use of pesticides illegal under Oman's legislation.

3. Problems with an unqualified labour force, for example with regard to proper use of pesticides.
4. Problems with small scale farms most of which are poorly managed especially in terms of the proper use of pesticides.
5. Problems with a perceived weakness in the government agricultural extension service as an instrument for helping to address points 2, 3 and 4 above.
6. Problems with the flow of information from the Ministry of Agriculture and Fisheries to the farming community.

As can be seen above, the respondents helped identify the key aspects of and problems with government support for agriculture. It was generally agreed that the use of expatriate labour is seen as a serious issue in Al-Batinah, especially in terms of their lack of training, their lack of education, their problem with the Arabic language, their misuse of pesticides and their injudicious consumption of water especially as their employment contracts are short-term. The respondents also raised the issue of Omani farmers illegally renting farms to expatriate labourers so compounding the problems associated with water and pesticide misuse. The concern was raised that harm to the agri-business community was done by the excessive use of chemicals including those pesticides banned under Omani law. The merits of the expatriate labour-force included hard work and cost effective salary structures.

There was consensus that farm size is limiting productivity and that inheritance laws result in farm holding fragmentation. All respondents agreed that the recently established Al-Batinah Farmers Association represents a potential solution to the problem of small scattered holdings especially since, through this association, farmers should be able to acquire agricultural materials more cheaply, make better production plans and explore new markets. There was agreement that the union would be able to represent the views of the farming community to state bodies. The key respondents also emphasized the importance of such associations in knowledge diffusion and practical information exchange. Most respondents suggested that similar associations should be established elsewhere in Oman.

The majority of respondents referred to the constraints that face the Ministry agricultural extension centres, citing the insufficient numbers of experts and consequent inability to visit all agricultural holdings. The scarcity of training programmes for farmers was also noted as was a relatively low level of confidence in the ability of the extension service to provide up-to-date advice. The majority of the respondents said that there were limited financial

resources available to the extension centres. The majority of respondents cited a lack of coordination between MAF and other government agencies, a lack of access to technical information at extension offices, difficulty in obtaining technical information from MAF sources by farmers and a communication gap between the Ministry and farmers in terms of implementing existing rules and regulations especially in relation to banned and restricted pesticides.

Based upon the key informant interviews it was clear that one of the key issues is the safe and effective use of pesticides in Oman and the inability of the traditional 'vehicle' for dissemination of information to address it. This raises the question as to whether there are alternative routes for training and dissemination of information, such as the farmer associations. Farmer-to-farmer dissemination has been well explored in the literature, but is relatively under explored in Arab countries of the Middle East. The effectiveness of the existing routes of knowledge diffusion in relation to pesticide safety was explored through a detailed survey of current pesticide use, labour awareness of pesticide regulations and knowledge transfer between farmers. A structured questionnaire was completed through face to face interviews with respondents representing members and non-members of the Al-Batinah Farmer Association as owners, owner/managers and managers between January and April 2012. The questionnaire aimed to explore the dynamics of knowledge diffusion and awareness of pesticide safety issues using quantitative (Likert-type scales) and qualitative (open) questions. One hundred and fifty one responses were collected; 44 from farms allied with the Farmer Association and 107 representing non-Association farms.

Questionnaire responses were analysed based on membership (FA) or non-membership (non-FA) of the Association. Both groups had similar profiles for farm size, number of employees and age ranges of respondents. FA farms had a significantly higher level of uptake of Integrated Pest Management and non-chemical intervention techniques for pest and disease control. The quantitatively-rated level of dependency on chemical pesticides was higher in non-FA farms. Responses to the question "Pesticides solve my Pest and Disease Problems" had modes for Strongly Agree for non FA farms and Agree for FA farms. Most non-FA farm responses indicated a pesticide consumption level similar to previous years whilst for FA farms most responses indicated a reduced level of pesticide input.

For non-FA farms the primary source of information about pesticides is the pesticide supplier; for FA farms the primary source of advice is from within the FA. Few farmers from

either group sought information from Ministry of Agriculture and Fisheries agricultural development offices; a point that echoes the concerns raised above. When asked about sources of information about illegal pesticides 90% of the non FA responses indicated that they had never been contacted by any government agency about such chemicals. From within the FA 75% responded that the FA itself had supplied information about banned pesticides. When questioned about safety equipment such as gloves and face masks, when mixing or applying pesticides, a majority of non-FA responses indicated that safety equipment was never used. In contrast the modal responses from FA farms were that safety equipment was usually or always used. Responses were also obtained about risks of pesticide use. From FA farms the most frequent responses indicated a concern for human health (95%) and the environment (84%); from non-FA farms 65% of responses recognised a risk to human health but 36% responded that pesticide use was without risk. When asked about how past expiry pesticides were disposed-off, most FA responses indicated that they store such pesticides (93%) or dispose of them according to FA advice (89%). From non FA farms the most frequent response was that out of date pesticides were disposed of in the soil (40%) or in manure mixes (63%). The most frequent method of disposing of empty pesticide containers on FA farms was to put them in municipal garbage (97% of responses); on non-FA farms the most frequent response was that such containers were burned (81%).

Simultaneous with the farm-based questionnaire, an inventory was taken of pesticides used. On the 44 FA farms 46 named pesticides were identified, on the 107 non-FA farms 94 named products were listed, representing 232 and 417 individually identified pesticide usages or 5.3 and 3.9 products per farm for the two groups. In terms of identified active ingredients, 36 and 61 were listed on FA and non-FA farms respectively, representing 0.82 and 0.57 active ingredients per farm. Individual active ingredients were rated according to the Pesticide Action Network (PAN) Pesticide Database. Although pesticide use appeared more diverse on FA farms, analysis of the types of active ingredients used on the two groups of farms indicated 65 and 207 instances of so-called PAN bad actor chemicals being used on FA and non FA farms, representing 28.0 and 49.8% of total pesticide usage on both farm groups. Analysis of the use of illegal pesticides on farms identified that dimethoate, prohibited under Ministry of Environment and Climate Affairs legislation, was being used on almost 20% of non FA farms but on only 1 FA farm. Similarly, methomyl at 90% WP active ingredient was found on 6 (5.5%) of non FA farms, but was not identified on FA farms.

The results indicate gaps in existing policy and provisions; legislation providing mechanisms by which expired pesticides should be disposed-of are lacking. At present farmers are instructed, according to ministry of environment and climate affairs, to store such pesticides but no policy or facilities exist on post storage treatment. Similarly farmers dispose of used containers in municipality bins or other conventional (non- hazardous controlled) outlets, but subsequent treatment of these containers is inadequately regulated or provided with mechanisms or facilities for disposal. Regulation and management of these hazardous waste items is inadequate; although technical solutions are available elsewhere, the slow pace of centralized decision-making appears to be perpetuating the current national problem.

The results also illustrate awareness gaps within the farming community, especially in relation to prohibited pesticides and the use of safety equipment. Most encouragingly, FA farmers were both more aware about prohibited pesticides and were more likely to use safety equipment. Knowledge diffusion appears much more rapid and effective within the FA arena and membership of such associations could significantly impact pesticide use and safety in the future. It would appear that farmers associations are a good means of bringing about EM given that these farmers more readily adopted IPM and non-chemical approaches to pest and diseases management. Future research will attempt to identify whether it is the farmers association that drives this move towards EM or whether member farmers are also those most likely to adopt EM strategies even in the absence of a farmers association.

Keywords: Oman, pesticides, farmer associations, ecological modernisation

## Access systems to sustainable compost transport in Ghanaian Savanna smallholdings

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### Introduction

The livelihoods model (Carney 1998) describes how farmers' access to five different types of capital affects the livelihood decisions and choices they are able to make.

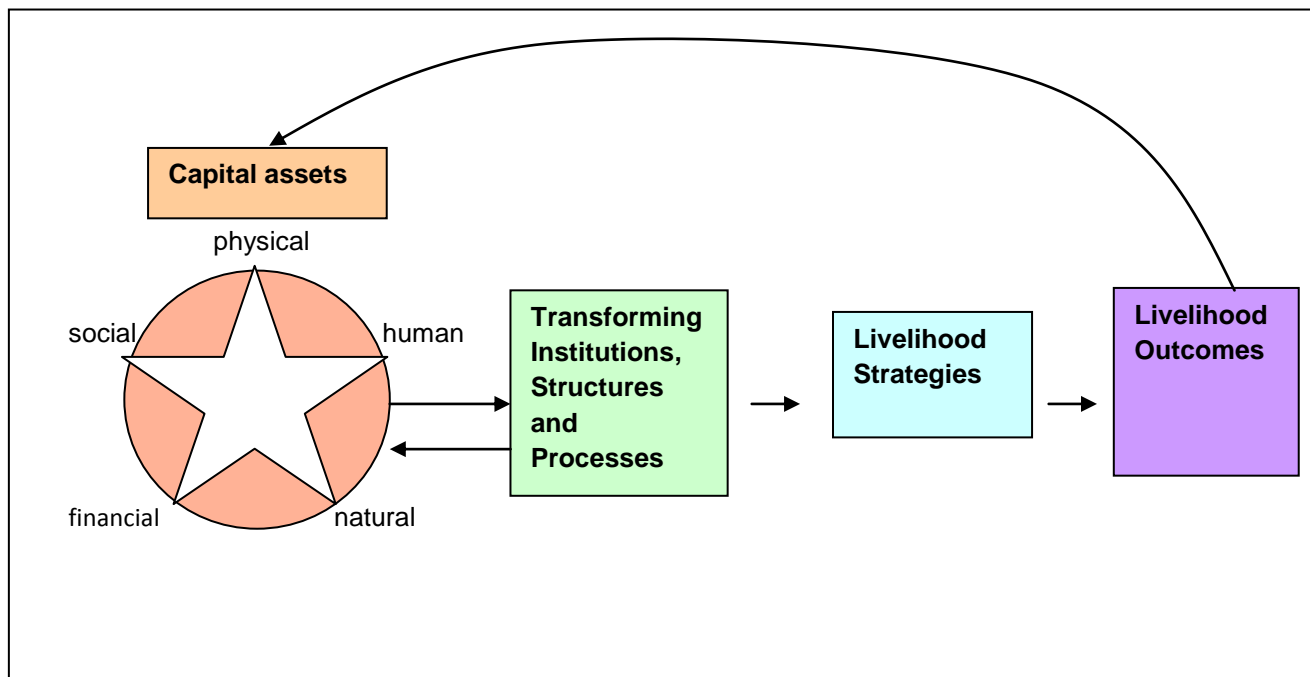


Figure 1- The Livelihoods Framework. Adapted from Ashley and Carney (1999) and DFID (1997).

In peri-urban West Africa, rapidly rising populations have led fertile land to become scarcer. Many farmers crop more frequently as a result, representing a decline in natural capital. Farmers who are no longer able to fallow adopt other livelihood strategies, involving other forms of capital, in order to sustain their access to fertile soils. One such method involves the application of organic soil amendments such as compost. Composting has proved a useful innovation, as its advantages range beyond merely levels of macro and micronutrients. Improved soil structure means water is more effectively retained, the use efficiency of inorganically supplied nutrients is enhanced, and soil biological



activity is encouraged (Woomer and Swift 1994). However, the low availability of raw materials like manure and crop residues means farmers cannot produce enough compost to make its practice sustainable. Another main constraint is the high labour requirement, as compost preparation is time consuming and its bulky nature means its transportation to the farm is difficult. (McClintock and Diop 2005). One of the tools farmers therefore need to be able to use compost effectively is a means with which to convey it to the field, and larger animal drawn vehicles are more desirable for such a purpose than the labour-intensive headpans and bicycles many have hitherto employed. A farmer's access to these different means of transport is governed by their capital endowment (Bellwood-Howard 2012) and regulated through various institutions that operate at multiple scales. Ownership by individuals and groups exists alongside hire markets and traditional systems of reciprocal and obligatory sharing and borrowing. This paper examines how those different systems interact with farmers' assets to determine their access to the vehicles they use to convey compost and, through that, their ability to sustain their agricultural livelihoods. Whilst recognizing that global as well as local institutions control access to the varied capitals farmers need to pursue sustainable agriculture, this study primarily focuses upon those that act at the village scale, using qualitative data to show that farmers' strategies are only sustainable if effective usufruct systems and social institutions are in place to facilitate them.

### **Study site and background**

These issues interact in two savanna villages in Northern Ghana, Ypilgu in Tolon-Kumbungu district and Zaazi in Savelugu-Nanton district in the Dagbon tribal area of Ghana's Northern region. As successive generations of smallholders in these communities have inherited diminishing land patches, they have adopted composting to maintain their farms' productivity (Karbo and Agyare 2002, Clotey *et al.* 2006) but now find that they cannot transport the volumes of compost they require to their fields with the bicycles and headpans available to them. The overall aim was to compare the role of financial capital in facilitating private ownership and a hire market with the role of social capital in participatory group formation.

The research was structured around three questions:

1. Although it is not the main subject of this particular paper, as a prelude, the study determined which of six modes of transport was best for farmers.
2. The main focus of this paper is upon which mode of vehicle ownership was preferable.
3. Related to this question, the study asked which scale each of these modes of ownership occurred at.

### **Methods**

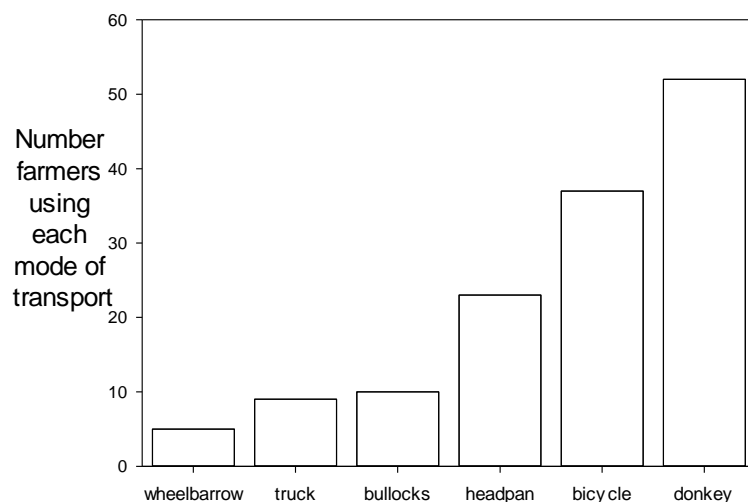
An experiment was devised to examine the characteristics and viability of systems through which farmers gained access to six vehicles: bicycles, headpans, wheelbarrows, bullock carts, donkey carts and hand carts. In 2010, fifty nine farmers agreed to participate in the experiment by testing at least two of these forms of transport under three different access systems. Firstly, representing self ownership, 37 of the 59 continued to use the bicycles and 23 the headpans they already owned to carry their compost. Secondly, investigating a participatory solution, 52 joined participatory groups instigated within the

study to gain access to wheelbarrows and a donkey and cart. Group members appointed a facilitator to oversee those vehicles' maintenance. Thirdly, some used vehicles hired from private owners by the researcher. Ten who owned bullocks used a hired cattle truck with their own draft animals and nine used a hired handcart.

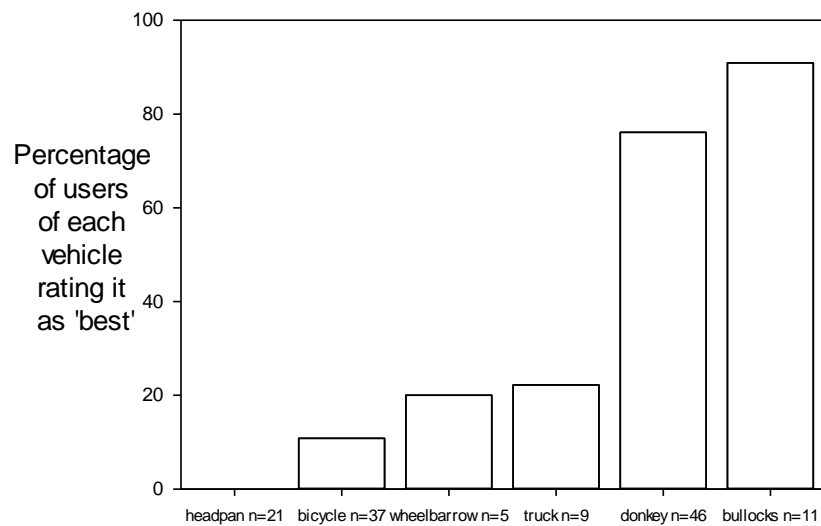
In addition, some participants autonomously hired bullock trucks and handcarts outside the experimental context, and other farmers who had not involved themselves in the experiments approached the participatory groups in order to hire their donkeys. These instances provided an opportunity to collect incidental data that was included in the results. Qualitative information forms the bulk of the data presented here: all 59 farmers were interviewed thrice about their experiences, discussing the pros and cons of each vehicle and mode of ownership. They ranked the different forms of transport they had used, naming their favourite and justifying their opinion. Another valuable tool was participant observation.

## Results

Smallholders used different types of capital to access the six vehicles through various ownership systems. The six modes of transport were differentially adopted by farmers and the extent to which they were used, shown in figure 2, can be taken as one indicator of their popularity, alongside farmers' rankings of them, shown in figure 3.

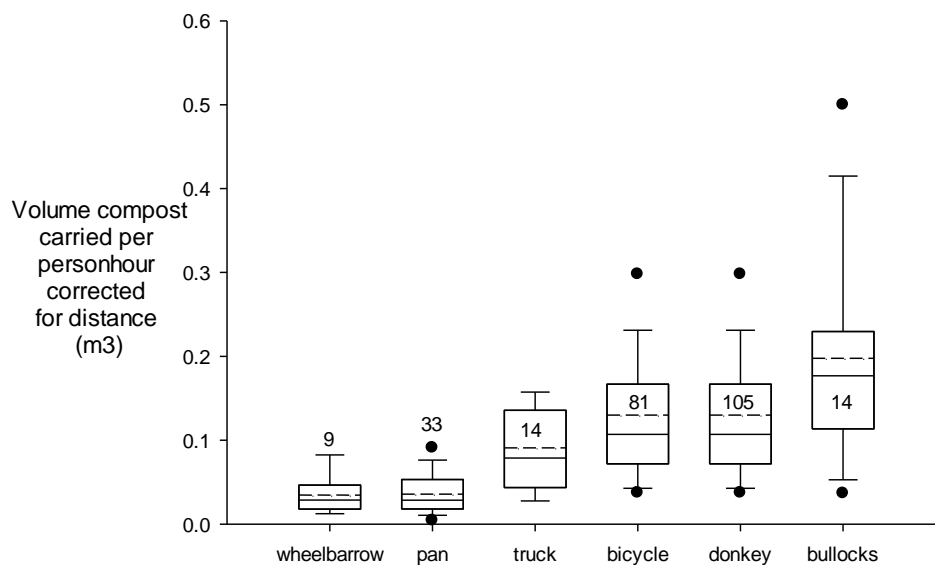


*Figure 2: Number of farmers testing each mode of transport*



*Figure 3 – Farmers’ rankings of each mode of transport. n=number of farmers participating in ranking exercise for each vehicle.*

Farmers’ opinions of each vehicle were informed by both the system of ownership under which they are used and their capacity. Figure 4 shows how the larger capacity of animal drawn vehicles meant they could carry higher volumes of compost for a given effort expenditure.



#### *Figure 4 – Carriage efficiency of each mode of transport*

The purpose of this paper is primarily to address not the capacity of the vehicles but the systems through which farmers gained access to them. However, it must be noted that the two are not discrete considerations. The largest, most efficient animal drawn vehicles are more expensive, meaning that their ownership by most individuals is precluded and they must therefore be used either through a hire or group mechanism.

The popular, high capacity bullock cart was actually used by only 10 farmers, as most of them did not own the physical capital of the livestock required to pull the hired cart: animals are not hired with the cart in Dagbon. The hired handtruck was even less highly rated and less well used, despite having been hired by the researcher and thus affording no cost to the farmers. Interviewees attributed this partly to the characteristics of the truck itself: pulling it entailed a high human capital requirement. In terms of the system under which it was accessed, the propensity of the owner who had hired it out to reclaim it for use by his own family was a disincentive to its use, illustrating one of the disadvantages of hiring. The donkey and wheelbarrow had been accessed under participatory sharing arrangements. The popularity of the donkey, demonstrated both by farmers' ratings and actual use of it, can therefore be ascribed firstly to the low cost of accessing it and secondly to its larger capacity in comparison to the wheelbarrow. The bicycle and headpan were widely used as farmers owned them themselves, although their low rating reflected their low capacity and high human capital requirements.

Ultimately, although farmers would prefer to use high capacity vehicles, the capital requirements of owning and hiring them are usually too demanding. Thus, participatory group ownership forms a viable alternative, enabling farmers to use vehicles like the donkey cart. However, the ease of access to small, affordable self owned modes of carriage like bicycles and headpans means these remain an integral part of smallholders' compost carriage strategies.

Interview and participant observation data revealed that these vehicles could be used within more than one of three groups of use systems: individual ownership, hire, or group mechanisms. Although each of these occurred at different scales, those of the individual, the household the groups and the community, each scale was not necessarily linked to a particular type of use system. Individuals and groups owned goods, hiring took place within and between communities and households and participation occurred within groups comprised of community members. The study had aimed to contrast the role of two different types of capital within these systems: that of financial capital, operating through markets and individual ownership, and that of social capital acting through participatory groups. A third system that emerged from the data was the role of social capital in traditional obligation.

#### **Financial capital in hire markets**

Financial capital was used at an individual scale as people used their own bicycles and headpans. Farmers producing for the market, predominantly young men and those growing vegetables rather than maize, carried their own compost to their farms using their own bicycles. As the profit from those vegetables would accrue to them, the capital they expended upon their production was obtained at the same individual scale.

Financial capital also facilitated a hire market, as individuals as well as the researcher did hire handtrucks and bullock carts from adjacent villages. Donkeys were already owned by two farmers in Zaazi and hired out for purposes like water carriage and transporting vegetables to market as well as conveying compost. In 2011, four households in Ypilgu obtained large animal drawn carts. These were either purchased with their own money, sold on credit by an NGO or received as a gift from a neighbour. Following these acquisitions, financial capital began to act on a community scale within this village as the carts were hired for compost carriage as well as conveying firewood and farm goods from the fields to the homestead. Financial capital thus began to substitute for the human capital necessary to the use of the smaller vehicles (Starkey 1990). This meant that the hire market advocated by commentators such as those writing for the World Bank (Malmberg-Calvo 1998, Riverson and Carapetis 1991) had begun to come into effect.

### **Bonding social capital in Participatory community groups**

Social capital was implemented at the group and community scale in the participatory solution. Following formation of the participatory groups, farmers contributed their time to meetings and negotiated with each other to arrange when they would use the group-owned donkey and wheelbarrow. The major cost of being involved in these groups was the compromises they were forced to make with respect to use of the donkey: as one vehicle alone was insufficient for use by all farmers they had to wait to use it. One participant, Kokonaa, described the necessary skill as 'patience', which in the parlance of participation can be termed 'social capital'.

### **Individual linking social capital between individuals**

It had been anticipated that endogenous social capital systems would have some influence upon the functioning of the participatory groups, but they also played out in a different way to describe a third usufruct system more related to interpersonal linking capital than community scale bonding capital. This system involved traditional norms of reciprocity and obligation. One manifestation of it saw the social capital of senior farmers acting in a less formal way at the household scale to oblige junior household members to assist them in carrying compost.

Interhousehold transactions were also facilitated by this type of social capital. Three instances were reported in interviews in 2010 where participants had borrowed bullock and donkey carts from kin in adjacent villages, as these vehicles were not available in the study communities. Following the 2011 acquisition of the larger vehicles in Ypilgu, participant observation revealed that social capital functioned at multiple scales when both these large and some smaller vehicles like bicycles were lent and borrowed between household, lineage and community members according to traditional patterns. In an example of this type of interaction, a household called Yapalsinayili borrowed the bullock cart from their family members in the adjacent village, Tarakpaa, in 2010. In 2011 they did so again, but it got a puncture so they went to their neighbour Tampionlana to borrow his new cart for that day. Traditional relationships thus facilitated their usufruct within kinship and community structures. An example of this type of mechanism operating at the household scale was recorded in a more quantitative fashion in 2011. Thirty four farmers were asked in interviews whether cattle could be equally accessible to different household members. Seventy-one percent said use of cattle could be shared within the household, explaining the only circumstances under which someone may be prevented from using their

relative's cattle was if they did not take good care of them (18% of respondents) or if a senior's field takes precedence (26% of respondents).

Farmers described how altruism as well as elements of the reciprocity (La Ferrara 2003, Thomas and Worrall 2002) and obligation (Kuyini *et al.*, 2009) integral to the traditional African labour economy are involved in this system (Berry 1993, Swindell 1985). Elements of all reasons are probably differentially significant for each individual.

This traditional system was an important mechanism for farmers who could not afford to own or even hire the largest, most efficient vehicles, but sometimes had the social capital that facilitated borrowing.

### **A range of capitals and scales**

Individuals' private accumulation of financial and physical capital seemed an expedient route to sustainable compost carriage in this context. The participatory group was difficult to maintain and to some extent began to resemble an ownership situation under the facilitators' direction, although they did not accumulate profit. Also, when people bought their own vehicles this facilitated not only a hire market but also the traditional sharing and borrowing system that ensured many in the community had access to a vehicle at some point. However, participant observation revealed that the poorest smallholders did not appear in the self-selecting survey and had scarce time for formal data collection. These farmers rarely had the social capital necessary to borrow others' vehicles or even recruit the labour to make compost. Interviewees also indicated that a participatory group was more likely to slightly improve the access of these poorest people to physical capital. This informed the conclusion that a range of different access mechanisms, acting at different scales, are necessary to make compost transport, and indeed sustainable agricultural practice in general, available to the widest range of farmers. Compounding this, the three scales and three themes identified in the results overlap within farmers' access systems - they hired vehicles between and within communities, shared and hired the group donkeys and lent to kin, household and community members according to traditional obligations.

These various scales have been described as differentially important between contexts. Critical participatory authors have questioned the utility of designating 'the community' as a locus for development (Francis, 2001), emphasising differentiation within it and the importance of other networks such as kinship, lineage, friendship, neighbourhood (Goldstein *et al.*, 2002) and gender (Vaughan, 1985). The 'household' has similarly been criticized as a description of an unrealistically homogenous unit (Russell, 1993, Vaughan, 1985). Nevertheless, in the study area both were sites of production and reproduction within which physical capital was usually accessible (Guyer, 1981). Different transactions may operate simultaneously at different scales and within different structures: Ramisch (2004) describes how reciprocal ploughing groups amongst Bambara/Senoufo farmers in Southern Mali are comprised only of kin, whereas manure exchanges may take place between those of different ethnicities within the same community. Trends like migration also change the relative importance of each over space and time: client-patron and household relationships override ethnic affiliation in the Zongo slums of urban Kumasi in Southern Ghana (Schildkrout, 1975).

This research shows that rather than one taking precedence over another, a range of scales and access mechanisms may coexist and interact within any setting. In the study communities farmers draw upon a variety of systems that act at different scales in order to facilitate effective and sustainable soil fertility and farm management.

### **Village scale interactions sit within a wider context**

These overlaps extend to actors and scales outside the immediate study context. Here the themes of transport and soil fertility have interacted at a local level, but they sit within wider national and global agricultural development pictures. Actors and processes framing this case study are the Structural Adjustment Policy that removed fertiliser subsidies in the 1980s, the state that reinstituted them in 2008 and the NGOs and private lenders who offer pre-season interest-bearing fertiliser loans (Guyver and McCarthy 2011)

### **Implications for policy and research**

Policy-makers and non-state actors seeking to implement sustainable development must consider which ownership systems and institutions best facilitate smallholders' access to the capitals they need for agriculture. The links and synergies between such systems at multiple scales are valid sites for future research, constructing a holistic picture of how sustainable different practices can be in different contexts. Further useful work can then focus on how to facilitate the most sustainable.

### **References**

Ashley, C., and D. Carney. 1999 Sustainable livelihoods: lessons from early experience. London: DfID.

Bellwood-Howard, I. 2012 Donkeys and bicycles: capital interactions facilitating timely compost application in Northern Ghana. *International Journal of Agricultural Sustainability* DOI:10.1080/14735903.2012.666030

Berry, S., 1993) No condition is permanent: The social dynamics of agrarian change, Wisconsin: University of Wisconsin Press

Clottey, V. A., Agyare, W. A., Gyasi, K. O., Schreurs, M., Maatman A., Abdulai H, and Dinku R. 2006. Composting to ensure food security: learning by doing. *Livestock Research for Rural Development* **18**: Article no. 137

DfID. 1997. Eliminating world poverty: a challenge for the 21st century . White Paper on International Development. London: DfID.

Francis, P. 2001. Participatory development at the World Bank - the primacy of process. In Cook, B. and Kothari, U. (eds) *Participation: The new tyranny?* London : Zed Books. pp.72-87

Goldstein, M., Sadoulet, E. and de Janvry, A. 2002. Is a friend in need a friend indeed? Inclusion and exclusion in mutual insurance networks in Southern Ghana. LSE STICERD Research paper DEDPS 32 . London: LSE

Guyer, J. I. 1981. Household and community in African studies. *African Studies Review* **24**: 87-137

Guyver, P. and MacCarthy, M. 2011. The Ghana grains partnership. *International Journal of Agricultural Sustainability* **9**: 35-41. DOI:10.3763/ijas.2010.0564:

Karbo, N., and Agyare, W. 2002. Crop livestock systems in Northern Ghana. In *Workshop on Crop-Livestock Systems in Dry Savannas of West Africa*, (eds.) Tarawali, G. and Hiernaux, P. Ibadan, Nigeria: IITA. pp.112 - 126

Kuyini, A. B., Alhassan, A. R., Tollerud, I., Weld, H. and Haruna, I. 2009. Traditional kinship foster care in Northern Ghana: The experiences and views of children, carers and adults in Tamale. *Child & Family Social Work* **14**: 440-449. DOI: 10.1111/j.1365-2206.2009.00616.x:

La Ferrara, E. 2003. Kin groups and reciprocity: A model of credit transactions in Ghana. Bureau for Research in Economic Analysis of Development Working Paper 27, North Carolina: BREAD, Duke University

Malmberg-Calvo, C. 1998. Options for managing and financing rural transport infrastructure. World Bank Technical Paper 411. Washington: World Bank

McClintock, N. C. and Diop, A. M., 2005 Soil fertility management and compost use in Senegal's peanut basin. *International Journal of Agricultural Sustainability* **3**(2): 79-91

Ramisch, J. 2004. Contending pathways of crop-livestock integration and the prospects of sustainable intensification in Southern Mali. In Williams, T. and Tarawali, S. (eds.) *Proceedings of the ILRI-IITA Conference on Sustainable Crop-Livestock Production for Improved Livelihoods and Natural Resource Management*: Wageningen, Netherlands:CTA/ILRI/IITA

Riverson, J., and Carapetis, S. 1991. Intermediate means of transport in Sub-Saharan Africa: its potential for improving rural travel and transport. World Bank Technical Paper 161. Africa Technical Department Series. Washington: World Bank.

Russell, M. 1993. Are households universal? On misunderstanding domestic groups in Swaziland. *Development and Change* **24**: 755-785. DOI: 10.1111/j.1467-7660.1993.tb00503.x:

Schildkrout, E. 1975. Economics and kinship in multi-ethnic dwellings. In *Changing social structure in Ghana: Essays in comparative sociology of an old state and a new tradition*, Goody, J. (ed) London: International Africa Institute pp.167-179.

Starkey, P. 1990. Animal Traction for Agricultural Development in West Africa: Production, Impact, Profitability and Constraints. In *Animal Traction for Agricultural Development. Proceedings of the Third Workshop of the West Africa Animal Traction Network* (eds.) Starkey, P. and Faye, A. Saly, Senegal: CTA. pp.1-30.



Swindell, K., 1985 Farm labour, Cambridge:Cambridge University Press

Thomas, J. and Worrall, T. 2002. Gift-giving, quasi-credit and reciprocity. *Rationality and Society* **14**: 308-352. DOI: 10.1177/1043463102014003003:

Vaughan, M. 1985. Household units and historical process in Southern Malawi. *Review of African Political Economy* **34**: 35-45

Woomer, P. And Swift, M. (eds) 1994.The biological management of tropical soil fertility. London: Wiley

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**GHG Emissions and Mitigation potentials in Agriculture, Forestry and Other Land Use sectors in Indonesia**

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**Background**

In Indonesia, around 65% of domestic GHG emissions derive from the Agriculture, Forestry and Other Land Use (AFOLU) sector (MoE, 2010) since primary industry shares a large part of the domestic economy. It is important to evaluate quantitatively and specify types of countermeasures with high mitigation potentials, upon which we should place a priority. TNA (MoE, 2009), DNPI (2010) and Rizaldi (2001) have dealt comprehensively with many types of countermeasures, and they estimated mitigation potentials for each countermeasure. However, they did not take into account time-varying impacts on emission and mitigation by historical land use change or countermeasures applied in the past.

To estimate mitigation effects of countermeasures considering historical land use change, we developed AFOLU Bottom-up Model for emission mitigation (AFOLUB, Hasegawa et al., submitted). The AFOLUB consists of two modules, namely the AGriculture Bottom-up module (AG/Bottom-up) and LULUCF Bottom-up module (LULUCF/Bottom-up). As the characteristics of the LULUCF module, it takes into

account (i) historical land use change, (ii) mitigation and cost in the different time scales and (iii) emissions and mitigation from fires, natural disturbances through land use change and peat lands. We aim to discuss mitigation potentials in AFOLU sectors in Indonesia using the two modules.

### **AFOLU Bottom-up Model for emission reduction (AFOLUB)**

The AFOLUB Model is a bottom-up type model for calculating GHG emissions and mitigation potentials in AFOLU sectors at the national/regional level, based on detailed information of specific mitigation countermeasures. The emissions and mitigation are calculated using Allowable Abatement Cost for GHG emission mitigation (AAC) which is a representative parameter representing a willingness of GHG reduction. The model calculates GHG mitigation and selection of GHG mitigation options (technologies) under several constraints for mitigation costs and mitigation potential, based on future assumptions of production in agriculture and livestock industry and land use change. Since the selection depends not only on evaluation methodologies of cost and mitigation but also applicability among technologies, we considered the applicability in the model. Information of specific mitigation countermeasures were collected from several international and domestic literatures. We prepared several evaluation methodologies and we compared and analyzed differences among amounts of technologies under several constraints of minimum amount of mitigation or maximum cost in each year.

The AFOLUB consists of two models; AG/Bottom-up and LULUCF/Bottom-up. The AG/Bottom-up calculates GHG emissions, combination of mitigation technologies and their mitigation in agricultural production and energy consumption of agricultural machines. The LULUCF/Bottom-up calculates GHG emissions from carbon stock change in biomass and soils on the land and those from fire, natural disturbance and peat lands and mitigations by specific countermeasures. The module does not take into account emission from wood harvesting. GHG emissions are calculated by following tier 1 or 2 of the IPCC guidelines (2006). We assumed that wood harvesting is not too large factor to make great impacts on change in land use and change in emission and sink coefficients. In the both module,

### **Application of AFOLU Emission Model to Indonesia**

#### **Framework**

Using the AFOLUB, we estimated GHG (CO<sub>2</sub>, CH<sub>4</sub> and N<sub>2</sub>O) emissions and mitigation in the AFOLU sectors up to 2030 in Indonesia. Countermeasures are applied from 2005 to 2030 and mitigation is calculated up to 2050 cumulatively or in annual steps. For

agriculture sector, we assumed a wide range of Allowable Abatement Costs (AAC): under 0, 10, 100USD/tCO<sub>2</sub>eq and over 100USD/tCO<sub>2</sub>eq for GHG emission mitigation in 2030. For the LULUCF sector, we assumed two typical and contrastive mitigation schemes using the mitigation and costs;

- a) These were selection of countermeasure in a term in order for maximization of total mitigation for each term under constraint of assumed cost for each term (SQF) and,
- b) Selection of countermeasure throughout the entire period from the present to the future in order for maximization of cumulative mitigation in the whole period under future cost constraints in the application term (WQ).

#### Assumptions and Settings

As an input to the AFOLUB, we prepared future scenarios of crop production, harvested area and yields of crops, number of livestock animals and area of land use and land use change. To consider the country specific situation, we referred basically to national statistics and publications such as the Indonesia Second National Communication to the UNFCCC (NC2) and for historical trends and future plans. If governmental plans or prospective are not available, future scenarios are estimated based on the historical trend from international statistics such as FAOSTAT(2011). We extrapolated trends of some activities up to 2030 using growth ratios calculated from the historical trends.

#### GHG emissions and mitigation in AFOLU sectors in Indonesia

Total GHG emissions in AFOLU sectors are estimated to be 660MtCO<sub>2</sub>eq/year in 2000. GHG emissions in the agriculture sector were 73MtCO<sub>2</sub>eq/year and GHG emissions and sink in the LULUCF sector are 835 MtCO<sub>2</sub>eq/year and -244 MtCO<sub>2</sub>eq/year, respectively. In the agriculture sector, the largest part of total GHG emissions comes from rice cultivations (37%), followed by managed soils (37%), livestock enteric fermentation (17%) and manure management (7.3%). In the LULUCF sector, in 2000, the emissions arise from peat land drainage (46%), followed by forest and grassland conversion (excluding peatland) (38%) and net emission from soils (17%).

In 2030, total GHG emissions are expected to increase up to 1.7GtCO<sub>2</sub>eq/year in the case without countermeasures. GHG emissions in the agriculture sector would increase 2.1 times and net emission in the LULUCF sector would increase 2.5 times from 2000. In agriculture, N<sub>2</sub>O emissions from livestock and managed soils are expected to increase drastically. 75% of the LULUCF emissions derives from peatland drainage.

Under 10USD/tCO<sub>2</sub>eq, 33MtCO<sub>2</sub>eq/year of GHG emissions, which is equal to 45% of agricultural emissions in 2000, can be reduced in the agriculture sector in 2030. In rice cultivations, midseason drainage and fall incorporation of rice straw are expected to reduce 7MtCO<sub>2</sub>eq/year and 4MtCO<sub>2</sub>eq/year of emissions in 2030. In the livestock, replacement of roughage with concentrates and dome digesters for cooking fuel and light are expected to reduce 6 MtCO<sub>2</sub>eq/year and 2 MtCO<sub>2</sub>eq/year. With regard to managed soils, high efficient fertilizer application (i.e. split fertilization) is expected to reduce 11 MtCO<sub>2</sub>eq/year. Expensive countermeasures such as slow release fertilizer were not selected under 30USD/tCO<sub>2</sub>eq. In contrast, countermeasures taking negative or zero cost, which are called "no regret options" (AAC is less than 0USD/tCO<sub>2</sub>eq), would reduce 21MtCO<sub>2</sub>eq/year in the agriculture sector. The largest potential countermeasure is mitigation drainage which would reduce 12MtCO<sub>2</sub>eq/year.

In the LULUCF sector, in the WQ case under a 1 billion mitigation cost in the entire period, 829MtCO<sub>2</sub>/year emission on average is expected to be reduced by countermeasures. This potential is equal to 1.2 times the quantity of LULUCF emission in 2000 and around 2.6 times from energy consumption in 2000. Enhanced Natural Regeneration (ENR) has the largest potential countermeasure. In the SQF, under the same amount of cost but annualized cost constrain, 695MtCO<sub>2</sub>/year mitigation is expected. The ENR is the largest potential countermeasure, followed by Reforestation (RF) and Afforestation (AF). From our study, it can be said that to design a mitigation pathway in the future, cumulative mitigation countermeasures and application schedule are required to be evaluated from a long-term viewpoint.