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Proceedings

Volume 1 of 3

Edited by:
João Joanaz de Melo, Antje Disterheft,
Sandra Caeiro, Rui F. Santos and Tomás B. Ramos

FACULDADE DE CIÊNCIAS E TECNOLOGIA
UNIVERSIDADE NOVA DE LISBOA
SCHOOL OF SCIENCE AND TECHNOLOGY

CENSE
center for environmental and sustainability research

ISDR Society

Proceedings of the 22nd International Sustainable Development Research Society Conference

ISDRS 2016

Rethinking Sustainability Models and Practices: Challenges for the New and Old World Contexts

Volume 1 of 3

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July 2016

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Proceedings organization

The ISDRS 2016 Proceedings are divided into three volumes, organized according to the Conference theme special tracks and the core ISDRS themes and tracks. Papers associated to posters are presented at the end of each theme chapter. At the end of each volume there is a complete authors´ index.

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Welcome to ISDRS 2016

The international Sustainable Development (SD) research community is faced with challenging sustainability threats and opportunities for emerging and fast changing economies and societies ("New World"). At the same time, it carries the accumulated knowledge about the models and results of countries with relevant past experiences in dealing with sustainability issues in more stable contexts ("Old World").

The major ISDRS 2016 conference theme focus on the current sustainability strategies, policies, practices and approaches and the need to rethink their roles and applicability in different socio-cultural and economic contexts. The ISDRS conference is one of the oldest world leading forums on SD, for exchanging and debate of cross cutting ideas, with exciting new research works, policy guidance and social gathering. Academia and practitioners will question the most challenging and pressing sustainability issues, exploring and learning about past, present and future collaborative paths.

This event is preceeded by the 1st Luso-Brazilian Symposium (July 11 to 12, 2016) on Sustainability Models and Practices, coordinated jointly by the Universidade Nova de Lisboa, Faculty of Science and Technology and the University of São Paulo, Institute of Energy and Environment. The aim of this pre-event is to strengthen research between these two Portuguese speaking countries, building bridges and synergies with the activities of the ISDRS, including its annual conference. The symposium covers the same themes of the ISDRS 2016.

On behalf of the Organizing Committee, we warmly welcome the participants of the ISDRS 2016 from around the world, coming from 47 countries and all continents, to an exciting three days conference. The conference is hosted by the FCT-NOVA, Faculty of Science and Technology of Universidade Nova de Lisboa, and our research centre, CENSE – Centre for Environmental and Sustainability Research, and the ISDRS – International Sustainable Development Research Society.

We would like to thank the Keynote Lecturers, Track Chairs, members of the Scientific Committee, sponsors, and all delegates for submitting and presenting their works in this international event on sustainable development. We wish you all a warm welcome and we hope that you enjoy the conference, Lisbon and Portugal.

Tomás B. Ramos
ISDRS 2016 Conference Chair

Rui F. Santos
ISDRS 2016 Conference Co-Chair

Sandra Caeiro
ISDRS 2016 Conference Co-Chair

Welcome message from the ISDRS

On behalf of the International Sustainable Development Research Society (ISDRS), we warmly welcome all delegates to Lisbon and the Universidade Nova de Lisboa!

A quarter century ago, in the times of the first UN Summit on Sustainable Development in 1992, researchers started to convene annually to discuss their analysis of the need for fundamental changes in the way human society deals with the ecosystems of which they are a part, propose solutions, and assess the progress made in implementing these in practice. These meetings originally centered around our 'root'-journals, but evolved into our currently globally active Society.

Now, we are together at the 22nd annual conference, and our main goal is to evaluate the progress made until this moment, listening to experiences from both the North and the South, from the East and the West. In organizing this year's conference in Lisbon, our hosts have been extremely successful in building bridges between the various communities of our single, one and only Earth, especially between the Old and the New worlds. Our Society is very grateful to our honorable friends at School of Science and Technology and the Center for Environmental and Sustainability Research. Our scientific debates in the coming days will directly feed into the wider global community of sustainable development researchers.

The ISDRS has grown more or less organically into a vivid international community of researchers in various relevant disciplinary fields around a number of highly successful journals such as Sustainable Development (since 1993), Environmental Policy and Governance (earlier: European Environment) (since 1991), Business Strategy and the Environment (since 1992), Journal of Cleaner Production (since 1993), Corporate Social Responsibility and Environmental Management (since 1994), and Progress in Industrial Ecology (since 2004). In complement to the work published in many of the natural science-based scientific journals, this worldwide community of scholars has been presenting strategies and methodologies for implementing solutions in the same wide range of societal fields that will also be addressed during this 22nd annual conf erence.

Since the early 1990s a large volume of research has been presented, showing successes, but also drawbacks, obstacles, and barriers for effective application of solutions that might originally have been presented with more optimism, than historical evidence has proven to be justifiable. Society often shows to be far more complex than anticipated: so these lessons need be taken to heart, evaluated, and translated into critically new approaches. Solutions need to be adapted towards diverse cultures, contexts and geographies. Here, the main themes of these days are timely: the need to rethink existing models and their applicability in different socio-cultural and economic contexts.

In the middle of this second decade of the 21st century, we see a very mixed picture of, on the one hand, progress, growing awareness, innovation, and optimism, while on the other hand, still continuously growing ecological impacts of our expanding human society, with its growing (middle-class) population, persistent global inequality, and fundamental failures in the (global) economic system to address these challenges. The conference themes for the coming days reflect these issues. It is our joint assignment to link the lessons learned about small scope solutions and incremental changes to more rigorous transitions needed. For taking up this challenge, here you are at the right place and at the right time.

We welcome you again to this 22nd annual conference with scholars who have traveled here from all continents of the world bringing your professional expertise, your ambitions, and your personal concerns about the future of our planet, our global society, as well as your local life history experiences. Together, we now have the opportunity to share our wide multidisciplinary knowledge, to synthesize our experiences, and to translate this in lessons learnt to actually achieve the newly agreed Sustainable Development Goals.

The ISDRS offers you an open platform during these three days in Lisbon, but also continuously in the weeks, months and years after. We invite you to continue connecting with your fellow scholars after the conference and to be a part of our active research working groups. As a participant of the conference, if you are not yet registered as a member of the Society, we invite you to still do so on www.isdrs.org. Our scientific discourses will be continued after July 15th in the various social media platforms connected to our Society.

Walter J. V. Vermeulen

President of the International Sustainable Development Research Society

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Center for Environmental and Sustainability Research, School of Sciences and Technology, Universidade Nova de Lisboa

The School of Sciences and Technology, Universidade Nova de Lisboa (FCT NOVA), Campus of Caparica, is one of the most prestigious Portuguese engineering and science public schools and it is engaged in extensive research activity developed in 16 research centres involving 1600 PhD and Master's students of the total enrolment of 7800. With a total of 550 academic staff (90% holding a Ph.D) and 180 non-academic staff, FCT NOVA is organized in 14 departments and 14 support services.

FCT NOVA partners with foreign universities such as the Massachusetts Institute of Technology (MIT), the University of Carnegie Mellon and the University of Texas at Austin to offer some of its advanced study programs. The entrepreneurial drive of the students and graduates of FCT NOVA has led to many successful spin-offs that transfer knowledge to the market and help create value and social impact.

One of the research centres of FCT NOVA is the Center for Environmental and Sustainability Research (CENSE). CENSE is devoted to the promotion of interdisciplinary research in environmental sciences and engineering, focusing in the interaction between human and ecological systems, to promote sustainable development. It is the research branch of a wider organization including researchers, students and staff from the Environmental Sciences and Engineering Department of FCT-UNL, plus a number of affiliated organizations (teaching and research, business and public organizations).

CENSE develops its activities through the promotion of research projects, outreach initiatives, training programs, collaboration with private and public organizations, dissemination of results and science-policy dialogues. Its funding is obtained from national and internationally funded research programs, as well as from other sources from public and private sectors.

International Sustainable Development Research Society

The official name of the organisation is the International Sustainable Development Research Society (ISDRS), first officially registered in Hong Kong in 2006. At that time ISDRS was built on a 13-year tradition of successful International Sustainable Development Research conferences originally in the UK. We are continuing this tradition and organize yearly conferences under the ISDRS flag, with in 2017 the 23rd conference in row. We generate and disseminate knowledge and educate others about sustainable development.

ISDRS has the following objectives:

- To generate research and knowledge about sustainable development;
- To disseminate knowledge about sustainable development;
- To educate others about sustainable development;
- To establish an information exchange for sustainable development worldwide.

The ISDRS is governed by a President and the Board of Directors.

Special tracks for the 22nd ISDRS Conference

A. Adaptive Sustainability Policies and Models in Changing Contexts

B. Oceans and Marine Sustainability: Innovation and Management

C. Sustainability Knowledge Sharing: From Individuals to Countries

D. African Perspectives on the Old and New World Challenges for Sustainable Development

Special track posters

Track A. Adaptive Sustainability Policies and Models in Changing Contexts

Session 0A-01

Session 0A-05

Session 0A-09

Policies for Ecosystem Services in rural areas to stimulate urban-rural migration

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Abstract

A shift is starting to emerge, with rural areas in non-metropolitan areas attracting urban population. Even though the process is more noticed in Northern European countries, its trend is increasing in Portugal, Spain and Greece. Previous research on this phenomenon in Portugal revealed that natural resources responsible for delivering ecosystem services (ES) are attraction factors in these territories, and consequently of its development. At the same time, in-migrants have been also responsible for the commodification of the countryside contributing to the transition from a resource production based economy to a change in priorities on fulfilling new lifestyles, or even environmental and aesthetic functions. As a result, ES are a driver that affects urban-rural migration phenomenon, while its delivery depends on the inflow of new ideas, influences and skills. Here lies the importance of addressing ES to improve the sustainability of these territories. The different categories of ES, such as regulation, provision and cultural, can guarantee sustainable livelihoods, and at the same time be a source of revenue in rural areas. This situation raises a question: how are international and European Rural Development policies addressing the delivery of ES in promoting rural living standards and population attraction? To support this study, the main sources of information are: (a) literature review, (b) questionnaires to Portuguese urban-rural migrants, (c) interviews to local stakeholders in Portuguese cases (d) and a review of initiatives and mechanisms that enable (and enhance) movements towards rural communities by newcomers. Results on policy analysis namely in countries with ongoing or emerging evidence on urban-rural migration are to be presented with the purpose of identifying policy conflicts and overlaps. Outcomes of this study are thought to be important to inform policy-making and help identify ways to promote sustainable pathways for development in rural areas through the population attraction.

Keywords: Ecosystem Services, Urban-rural migration, Policy analysis, Sustainability

Strategic Environmental Assessment in developing countries: particularities and impacts on decision-making in a non-mandatory context

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Abstract

Strategic Environmental Assessment (SEA) has presented a growing interest in the international literature. Despite the diversification and global spread of this instrument, research on SEA has focused mostly on its application by developed countries characterised by structured planning processes with a strong influence of legislation. Little is known about context influence and the effectiveness of SEA in developing countries, where SEA is normally applied in a non-mandatory basis and, therefore, with various approaches and different contexts that are presumably relevant to the outcomes. In this sense, the present paper analyses contextual aspects and SEA impacts on decision-making as already reported by literature. The background research uses Brazil as a single case study of developing country. A systematic review of literature related to the application of SEA in the country was conducted, resulting in a total of 24 papers published between 2008 and 2015. Existing practice was evaluated, examining contextual characteristics and the influence SEA showed to have on strategic decisions. The results reveal a crescent number of papers published by year. Effectiveness is found to be the most significant focus of SEA literature when reporting cases in Brazil. The outcomes allowed to highlight a number of contextual aspects that influence the structure and organisation of the SEA system in the country, such as: lack of SEA guidelines and procedures defined by legislation; influence of EIA practice on SEA; and a strong influence of the environmental licensing culture. In addition, regarding substantive contributions, SEA has demonstrated to contribute to improve communication between stakeholders during the planning processes, and also provided a better level of information to the lower tiers of decision-making. On another hand, literature reports only minor influences on the nature of the PPP at hand, with only one case clearly considering SEA recommendations at that level. Results also suggest that valuable lessons were learned through the SEA processes. It is concluded that current practice in Brazil indeed resulted in impacts on decision-making, although to different extents. The case study suggests that there is a clear potential for the use of SEA in Brazil in order to positively influence the development of strategic actions. However, its application must be adapted to contextual factors involving policies, plans and programmes formulation.

Keywords: Strategic Environmental Assessment, developing countries, SEA effectiveness, context influence, Brazil

1. Introduction

Strategic Environmental Assessment (SEA) is a supporting instrument that add scientific rigour to decision-making making by introducing environmental concern early in planning processes (Fischer, 2007). To date, the uptake of SEA has been greatest within the context of developed countries (Tetlow and Hanusch, 2012), characterised by structured planning processes with a strong influence of legislation. Most of research and literature also reflects a developed country perspective (Fischer and Onyango, 2012; Li and Zhao, 2015).

Overall, there have been few empirical investigations of SEA to understanding the tool efficacy, in particular, its impact on planning and development. Especially in developing countries, little is known about context influence and the effectiveness of SEA (Fischer and Onyango, 2012), where SEA is normally applied in a non-mandatory basis (Alshuwaikhat, 2005; Dalal-Clayton and Sadler, 2005) and, therefore, with various approaches and different contexts that are presumably relevant to the outcomes (Malvestio and Montaño, 2013; Fischer and Gazzola, 2006).

The purpose of this study is to analyse contextual aspects and SEA impacts on decision-making as already reported by literature. The background research used Brazil as a single case study of developing country.

In the next section, methods are explained. Section 3 provides results and discussion of the analysis of SEA contextual aspects and the tool impacts on decision-making. In the final section, main conclusions are summarized.

2. Methods

One goal of the literature review is to identify the current state of knowledge of a topic (Matthews and Ross, 2010). In this research, a systematic review was conducted using the methodological approach developed by Torgeson (2003). This method has the advantage of identifying all the available evidence of a given subject (Torgeson, 2003).

The literature review is exclusively based on a systematic analysis of Brazilian academic SEA literature. We identified a total of 24 papers published between 2008 and 2015. These articles were identified through searching publications in multidisciplinary citation databases. 'Strategic environmental assessment' and 'Brazil' were used respectively as a keyword search term and country affiliation. Selected Masters and PhD theses were also used for supplemental or background information.

Data analysis

In each paper, impacts of SEA on decision-making and respective context specificities were identified, which were then compared to SEA international literature related to the subject. The analytical review framework was based on three guiding questions including (i) what influence SEA had on decision-making? (ii) what are the context aspects associated to the SEA impact on decision-making? (iii) what are the characteristics of the Brazilian SEA system?

In this study, the concept of context in relation to SEA is the same as the one described by (Hilding-Rydevik and Bjarnadóttir, 2007). Context is the set of facts, conditions or circumstances that have an influence on the chosen approaches to SEA and on the outcomes of SEA implementation. Context is also the set of facts or circumstances that influences the chosen aim, goals, expectations, steps and methods of implementation associated to SEA (Hilding-Rydevik and Bjarnadóttir, 2007). By 'impact' in this study, we refer to the influence of SEA on the contents of a strategic action, on decision-making, on the participants and organizations taking part in the planning process, in both the short and the long terms (Runhaar and Driessen, 2007).

3. Results and Discussion

Papers focus

Figure 1 shows that the number of papers published by year exhibits continuous growth. These studies constitute an important step towards advancing the current knowledge of SEA within developing countries. Currently there is a growing body of SEA literature; however much of SEA research globally is taking place in research institutions localized in developed countries (Fischer and Onyango, 2012).

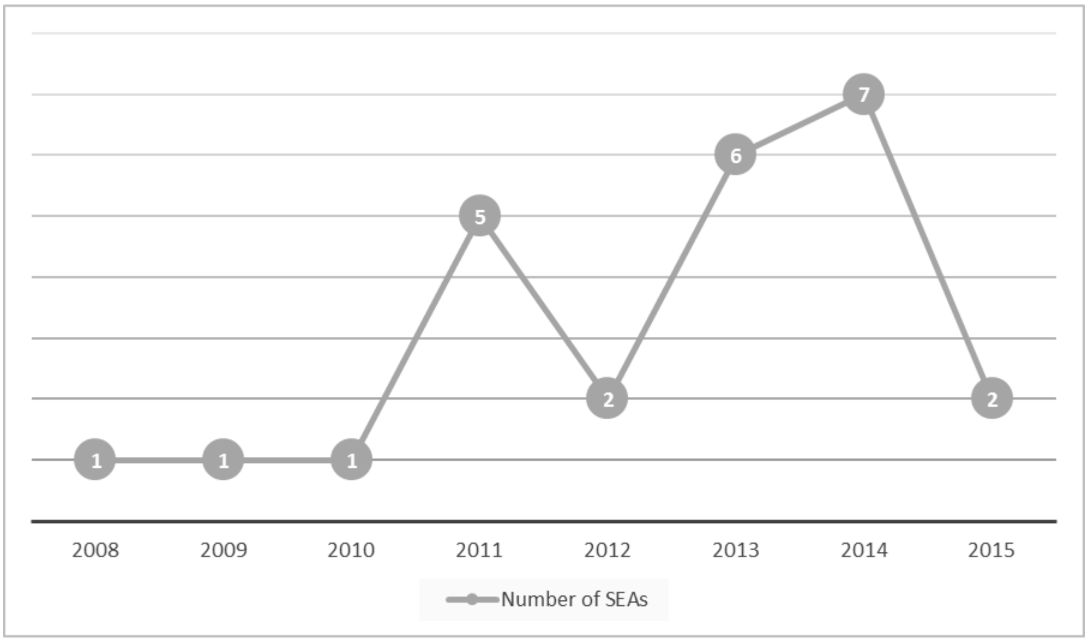

Figure 1. Papers published by year from 2008 to 2015.

Regarding the focus of Brazilian SEA papers, besides SEA, effectiveness was the most commonly used keywords (Table 1). Different aspects of effectiveness were addressed in the studies, including the review of procedural compliance of SEA applied to renewable energy (Malvestio and Montaño, 2013) and the analysis of SEA experiences within specific context characteristics (Silva et al., 2014). While SEAs reached a relatively high level of procedural effectiveness, they perform poorly in terms of substantive effectiveness (Malvestio and Montaño, 2013; Margato and Sánchez, 2014). The very low level of SEA influence on decision-making suggests that procedural effectiveness is by no means an assurance of substantive effectiveness and that good report quality does not guarantee outcomes (Margato and Sánchez, 2014). There is a need to distinguish the impact of this tool on decision-making.

Table 1. Focus of Brazilian SEA papers.

Keywords	**Frequency in %**
SEA	21,3
Effectiveness	6,7
Brazil	6,7
Sustainability	4,5
Environmental impacts	3,4
SEA systems	2,4
Social participation	2,4
Environmental planning	2,4
World Bank/Inter-American Development Bank	2,4
Quality review	2,4
Land use impacts	2,4
Energy Plan	2,4

Protected areas	2,4
Hydropower	2,4
Methods	2,4
EIA	2,4
Others	31

Sustainability was also well considered. Silva et al. (2014) analysed and characterised the use of sustainability indicators in 32 Brazilian SEAs. This study identifies four groups of SEA that consider sustainability indicators when setting the baseline (five SEAs), establishing a parameter for assessment and monitoring (11 SEAs), evaluating impacts (four SEAs), and conducting effectively the assessment (10 SEAs). Lemos et al. (2012) reviewed 10 SEA reports including one Brazilian SEA report suggesting sustainable issues that could have been better addressed in the assessments. According to the literature, sustainability is useful to describe the baseline and design the monitoring of PPP implementation in a SEA process (Fischer, 2007; Therivel, 2004). Further, it is believe that SEA has the potential to promote sustainable development by changing ways decisions are made (Partidário, 2000).

Regarding environmental impacts, emphasis is placed on especially the use of SEA within the sector of tourism and energy taking into account the Brazilian context to make the tool more useful (Lemos and Souza, 2010; Westin et al., 2014; Andrade and Santos, 2015). Context is relevant to ensure the influence of SEA on a PPP. Fischer and Gazzola (2006) report that SEA is most effective when adapted to the PPP context. Along similar lines, Brown and Therivel (2000) advocate the integration of SEA with the PPP development and decision-making process.

Others studies focus on, amongst others, SEA systems, Social participation, Environmental planning, World Bank/ Inter-American Development Bank. Overall, the research agenda to date has clearly been biased towards specific issues such as sustainability, environmental impacts, and protected areas. Few studies gave consideration to the Brazilian SEA system.

SEA impact on decision-making

Table 2 summarizes the results in terms of impact SEA showed to have on strategic decisions, SEAs and contextual factors associated. Findings indicate that the SEA of the São Paulo Metropolitan Ringroad Programme has induced the Project reformulation considering multi-sectorial integrated actions together (Sánchez and Silva-Sánchez, 2008). Considering the lack of formal requirements for SEA in São Paulo State and difficulties in obtaining approval,of the Rodoanel project (now called São Paulo Metropolitan Ringroad Programme), SEA emerged as a path to ease the approval. It tested the hypothesis of independent, self-standing, sections of the project. This hypothesis was implemented shifting the former project to programme involving a set of “integrated multi-sectorial actions”. It is to be noted that though the decision to build the highway had already been taken some years before the SEA conduction, the tool did still have some influence on decision-making. This finding is broadly similar to the results obtained in other countries. Acharibasam and Noble (2014) reported that SEA in Canada provided information to better align the PPP with stakeholder concerns and interests. In Estonia, the influence of SEA was largely expressed through its ability to change the policy document content (Peterson, 2004).

Table 2. Impact of SEA on strategic decisions and related contextual factors.

SEA	impact identified	contextual factors
São Paulo Metropolitan Ringroad Programme	- Project reformulation considering multi-sectorial integrated actions together - Consideration of each major	- AAE requested to facilitate project approval - The decision to build the highway had already been

	section of the Ring Road as an independent project - Prioritization of South section construction, in order to link the end of the west section to the major highways leading to the Santos seaport - Consideration of SEA recommendations in subsequent EIAs, including: definition of spatial boundaries of the project subject to EIA; issues to be addressed in the EIAs; selection of alternative corridors.	taken some years before the SEA conduction - Instrument focusing on justification of certain decisions taken to facilitate EIA approval
Corumbá Mining and Industrial District	- Involvement of mining companies operating in the region - Notification to decision makers of alternatives to consider - Use of SEA as a guiding reference document for planning and complex management - Use of SEA as reference for the sustainable development of the region	- SEA requested to comply with the safeguard policies of Multilateral Development Agencies - Applications requested to anticipate EIA conflicts, facilitating its approval
Program for Tourism Development in the North Coast	Use of SEA to guide the formulation of a methodological procedure adopted in other regions in accordance with the commitments with the IADB - Enhancement of institutional learning	Restricted public participation and lack of coordination and synergy between the federal and state actions
Multimodal Transportation and Industrial Development in the Cocoa Region	Consideration of SEA guidelines and recommendations during the process of environmental licensing (mandatory procedure in Brazil) of ventures with high polluting potential.	Conflicts between biodiversity conservation and tourism activities.
Hydropower Generation in Minas Gerais	Positive learning through SEA practice	SEA required to support decision-making on hydroelectric expansion in the state of Minas Gerais
Expansion of Eucalyptus and Sugarcane Plantations in Southern Bahia	Positive learning through SEA practice	SEA required to promote sustainable decision on the expansion of eucalyptus forests and biofuels.
Chopim river basin.	Positive learning through SEA practice	SEA required to serve as a reference for the assessment of power plants to be implemented in the watershed

Sub-basin of the Rio Verde	Positive learning through SEA practice	SEA required to assess potential conflicts and impacts related to the implementation of hydroelectric activities in the river basin
Turvo river basin	Positive learning through SEA practice	- SEA required to support hydroelectric activities

Sources: Silva et al. (2014); Sánchez and Silva-Sánchez (2008); Malvestio and Montaño (2013); Montaño et al. (2013).

Other SEA impact includes the use of SEA findings beyond the PPP or decision context. Recommendations of the SEA applied to the São Paulo Metropolitan Ringroad Programme were considered in subsequent EIAs (Sánchez and Silva-Sánchez, 2008). SEA applied to Corumbá Mining and Industrial District contributed in an important way to guide planning and complex management, and sustainable development of the region (Silva et al., 2014). Similarly, SEA of the Multimodal Transportation and Industrial Development in the Cocoa Region has also influenced the process of environmental licensing (mandatory procedure in Brazil) of ventures with high polluting potential. Looking at the three SEAs, it can be said that they are comparable in that both assessments were applied to anticipate future conflicts and ease EIA approval (Sánchez and Silva-Sánchez, 2008; Silva et al., 2014). Regarding the SEA of the Program for Tourism Development in the North Coast, restricted public participation and lack of coordination and synergy between the federal and state actions were the major constraints. However, the SEA could provide information for formulating a methodological procedure for SEA adopted in other regions in accordance with the commitments with the IADB (Silva et al., 2014). Further, this SEA was an opportunity to improve communication between stakeholders and enhance institutional learning through the Ministry of Tourism's commitment and involvement in the participation process (Silva et al., 2014).

Along similar lines, Turkish experience regarding SEA influence beyond PPP or context decision has shown that this tool can enable the streamlining of projects EIA. SEA was thus seen as a means of reducing time and ease obtainment of EIA approval (Unalan and Cowell, 2009). In Germany, Fischer et al. (2009) mentions that rejection of certain infrastructure project proposals as being a consequence of the spatial plan SEA process. In Canada, it is reported that SEA had helped to realize broader institutional goals, beyond the scope of the PPP (Acharibasam and Noble, 2014).Literature on SEA in Brazil reports also on positive learning through SEA practice. Montaño et al. (2013) noted the slow, but constant increase in the procedural performance of Brazilian SEAs. This is consistent with information reported in SEA applied to the Multimodal Transportation and Industrial Development in the Cocoa Region. The assessment report refers to several SEAs including those applied to Corumbá Mining and Industrial District and Açú Industrial and Harbor Complex as reference practices to evaluate investment strategies related to the mining and industrial sector as well as the transport logistics sector (Lima, 2008). According to Unalan and Cowell (2009), by the second application, actors involved in the SEA process had deeper knowledge of the tool from previous experience. There is a need for improved follow-through and follow-up on SEA to ensure learning through its practice (Acharibasam and Noble, 2014).

Context characteristics

The analysis reveals three categories of context characteristics including: (i) characteristics of the whole Brazilian SEA system, (ii) characteristics related to each SEA, and (iii) characteristics related to each SEA influence.

Box 1.

- Lack of SEA guidelines and legislation.

- SEA applications refer to three different situations: (i) SEAs requested by state or federal governments; (ii) SEAs requested by Multilateral Development Agencies; (iii) SEAs requested by the private initiative and society.

- Influence of the prevailing view of SEA as a tool applied to obtain the approval of funding requests or to facilitate the approval of projects EIA.

- Strong influence of environmental license1 culture.

- Influence of EIA practice on SEA

- Weak link between SEA and decision-making.

- SEAs applied to large projects.

- Limited public participation.

- Lack of available data on social and environmental aspects.

Source: Several authors including, but not limited to, Andrade and Santos (2015), Malvestio and Montaño (2013), Sánchez and Silva-Sánchez (2008), Silva et al. (2014).

Brazilian SEA literature gives consideration to the country SEA system (Box 1). Overall, most of studies refer to the absence of SEA regulations as the principal characteristic of Brazilian SEA system. Montaño et al. (2011) reported on the institutional setting for the implementation of SEA in Brazil. Authors highlighted that both draft and definitely enacted legislation lack definition of contextual factors such as where and how the application of SEA is necessary. Therefore, SEA cannot be considered legally accepted as its application is conducted on a voluntary basis (Montaño et al., 2011).

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1 Environmental licensing is an administrative procedure through which the environmental agency authorises the location, installation, expansion and operation of initiatives considered effectively or potentially polluting or those that can cause the degradation of the environment in any way (Oberling et al., 2013).

Lack of SEA guidelines and legislation was also found to be the main and common characteristic to most of developing countries (Alshuwaikhat, 2005; Walmsley and Patel, 2011; Rachid and Fadel, 2012; Montaño et al., 2014). Several authors discuss the necessity to adopt legal requirement for SEA. On one hand, SEA adoption is found to be important to facilitate the SEA application in an institutional system of restricted collaborative planning and dominating powerful interests (Hildén et al., 2004). On the other hand, some authors advocate that there is a need of high level commitment and capacity for conducting SEA prior to the tool introduction in a given country. Without this initial requirement, there is no point in making this tool mandatory (Slunge and Loayza 2012; Mota et al., 2014).

Margato and Sánchez (2014) provided a list of SEA applications in Brazil from 1994 to 2011. It is to be noted that Brazilian SEA applications refer to three different situations: (i) SEAs requested by state or federal governments, sometimes through their secretariats and environmental agencies; (ii) SEAs requested by MDAs; (iii) SEAs requested by the private initiative and society. Of particular concern is the important role played by MDAs. These agencies use this tool to safeguard environmental interests and contribute to environmental governance (Richardson and Cashmore, 2011; Cashmore et al., 2014). In developing countries, SEA is largely driven by MDAs. Tshibangu and Montaño (2015) reported 193 SEAs required by the four main MDAs from 1993 to 2012. The continuous growth observed during this period reinforces the role played by these agencies to the SEA application in developing countries.

In Brazil, some SEAs are applied to facilitate the approval of project EIA. In the private sector, entrepreneurs resorted to SEA to reduce environmental risks and uncertainties, which often increase costs and duration of projects EIA, likewise what has been observed elsewhere (see Marshall and Fischer, 2006). On the other hand, some initiative emerged from the approval process of project EIA. This was the case of the SEA applied to São Paulo Metropolitan Ringroad Programme. To avoid the potential refusal of the project, proponents resorted to SEA to test the hypothesis of self-standing sections project (Sánchez and Silva-Sánchez, 2008). These findings reveal a strong influence of environmental license culture. SEAs are not always applied as a means to insert the environmental dimension into the decision-making process. It is seems that mostly the primary intent is to obtain the initiative approval. There is a weak link between the assessment findings and decision-making as SEA suffers from the absence of a clear decision-making context (Margato and Sánchez, 2014). Further, findings reveal the influence of EIA practice on SEA: that is the process starts with a proposed strategic action and its impacts are assessed, resulting in raising recommendations for mitigation and compensation or improvements. However, there is little influence of SEA on the initiative implementation (Teixeira, 2008; Malvestio and Montaño, 2013).

Findings also reveal that SEAs are applied to large projects. Ideally, “SEA is applied in strategic decision-making contexts that precede project decisions” (Fischer, 2007). The application of SEA to lower tiers of decision-making was found to occur in others countries. Within MDAs, for example, most of SEAs are applied to large projects (Tshibangu and Montaño, 2015). Mostly actions are named “projects”, but contain components of high level initiatives. In Brazil, decision related to the location and economic alternative of large projects had already been taken prior to the SEA application or even before the conduction of the project EIA (Silva et al., 2014). Often, as reported by Teixeira (2008), SEA aims to complement project EIA or provide guidance.

Regarding the public participation, it is to be noted that the public participation is very limited in Brazil (Malvestio and Montaño, 2013; Margato and Sánchez, 2014). There is poor involvement of stakeholders as the participation is limited to public hearings (Malvestio and Montaño, 2013). There is a need to improve participation process for many reasons: it helps increase the credibility, transparency and accountability of end results (Acharibasam and Noble, 2014; Thérivel and Minas, 2002); it is a vehicle to communicate information (Walker et al., 2013); and it ensures a greater ownership of the final PPP by the public (Rega and Baldizzone, 2015).

Finally, findings show that the lack of data is also a characteristic of the Brazilian SEA system. According to Alshuwaikhat (2005), this deficiency observed commonly in developing countries affects the anticipation and monitoring of environmental effects. It is acknowledged that data can have relevant repercussions on SEA as they help define what SEA is about. However, even when data are available, there is a need to clearly specify what data to use and why (João, 2007).

4. Conclusions

The main aim of this study was to analyse contextual aspects and SEA impacts on decision-making as already reported by literature. Brazil served as a single case study of developing country. A systematic review of literature related to the application of SEA in the country was conducted. We evaluated the existing practice based on contextual factors and the influence SEA showed to have on strategic decisions. We identified a total of 24 papers published between 2008 and 2015. Their analysis reveal a crescent number of papers published by year. Effectiveness, sustainability and environmental impacts were found to be the most significant focus of SEA literature when reporting cases in Brazil. Of particular concern was SEA substantive effectiveness. Cases analyzed reached a low level of substantive effectiveness. Nevertheless, SEA has demonstrated to contribute to improve communication between stakeholders involved in the planning processes, and provided a better level of information to the lower tiers of decision-making. On another hand, literature reports only minor influences on the nature of the PPP at hand. Results also suggest that valuable lessons were learned through previous SEA processes. Contextual aspects related to the structure and organization of the SEA system in the country include: lack of SEA legislation; strong influence of the environmental licensing culture; influence of EIA practice on SEA; limited public participation; and Lack of available data.

It is concluded that SEA practice in Brazil indeed resulted in impacts on decision-making, although to different extents. The case study suggests that there is a clear potential for the use of SEA in Brazil to influence positively the development of strategic actions. However, its application must be adapted to contextual factors involving PPP formulation. For SEA to be effective, it needs to be linked to a well-defined decision-making context where its input can be discernible.

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Scarcity in abundance: The challenges of promoting sustainable energy access in rural village communities in Botswana, Southern Africa

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Abstract (300-500 words):

Botswana rural village communities account for 57.4% of the 2.1 million population and according to the 2014 Botswana Power Corporation annual report, have an average access rate to modern energy of 62.58% compared to averages ranging from 55% to 100% in the urban areas. Endowed with one of the highest solar radiation potentials in the world, Botswana's rural communities continue to perpetuate the paradox of energy "scarcity amid abundant but untapped" conventional fossil and renewable energy resources. Renewable energy systems implemented by development programmes however often lead only to transient solutions. This makes the quest for sustainable means of promoting rural energy access necessary amid multifaceted challenges hindering such access. We hypothesise that despite their apparent technical feasibility, rural PV systems are only sustainable if tied by policy to the diversification of rural livelihood activities. Informed by the energy metabolic pattern at the rural village Mmokolodi in Botswana, the paper envisions an energy policy planning based on the results of a Multi-Scale Integrated Analysis of Societal and Ecosystem Metabolism (MuSIASEM) project case study. Despite their proximity to the capital Gaborone, the majority of Mmokolodi's population has no access to modern energy. Data for the pattern of energy use at Mmokolodi was collected using participatory structured questionnaires and Participatory Geographical Information Systems methods and analysed using the MuSIASEM framework. The results show that a sustained access to electricity invested in socio-economic activities could act as a multiplier of endogenous financial income streams. We conclude that, instead of offering solar photovoltaic systems as mere technological solutions, the primary energy policy goal ought be support of identified rural income-generating activities and supplying their end-use demands by best available primary energy source(s).

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Keywords:

integrated analysis, participatory appraisal, sustainability assessment, energy access, rural endogenous development

Policy assessment and the relations with sustainability governance: an integrative review

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Abstract

Governance and sustainable development are recent concepts that emerged in the late 1980´s and had a large diffusion on the professional and academic discourses. Nowadays sustainability governance becomes a strong way towards sustainability and is widely accepted as a promoter of sustainable development objectives, aggregating a large set of key features and components, that must be supported in a qualified regulatory system that deserve to be analyzed in a structured context. In this context, policy assessment became relevant as a fundamental instrument in decision-making process to consider the environmental and sustainability issues and promote a sustainability studies focus movement upstream in the policy-making process as a prerequisite towards better sustainability governance, in a world of complex and dynamic systems. In this context the main goal of this research is to assess the extent of policy assessment contributes to sustainability governance, based on an integrative review and analysis of concepts, methodologies, and international practices, organized in a conceptual framework. This study also aims to evaluate the state of art and the present knowledge improvement on sustainability governance and policy assessment. The preliminary results showed the principal contributes drivers on the sustainability factors, and also legal and institutional aspects, with their links and latent drivers to the state, institutions, community, and economic sectors, and reveals critical aspects to consider and minimize, like the nonexistence of a systematic and structured strategy to promote the regulatory analysis, a lack public participation and stakeholder's involvement, political interference, lobbies, and a minimal cross-sectorial policy integration. Based on this results it was established a recommendation framework in order to eliminate or mitigate de adverse aspects and to enhance the positive ones that have an improvement potential. The main findings confirm policy assessment as crucial instrument to support the public policies decision-making process as part of the sustainability governance promoting the sustainable development goals.

Keywords: Sustainability, governance, assessment, policy

An examination of Chinese responses to sustainability accountability: the move towards ecological civilization from a Foucauldian episteme-change perspective

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Abstract

This paper considers that the contingencies in place in China around sustainability are unique for a major emerging economy. Chinese actors in the sustainability network are dominated by government, not corporations, and the links to ancient Chinese philosophy, whilst not immediately apparent, do persist. Furthermore, China is the first major economic power to commit to a new developmental direction, to become an ecological civilization. To study this situation, this paper focuses on providing both theoretical insight and empirical findings to answer the question – "Can China move to new accountability for sustainability based on ecological civilization?" Much of the existing research on Chinese responses to accountability for sustainability has been based on corporate responses. Because of the high profile of the authoritarian Chinese government, this study extends this analysis to political regions which are based on Chinese provinces and provincial environmental protection agencies. Foucault's insights into episteme change are used to understand sustainability accountability in the Chinese context and to represent findings in a new development model. This model is explained with regard to a transition from the Modern to an emerging episteme represented by the ecological civilisation concept now adopted by the Chinese government. Documentary analysis is used to provide key themes and evidence. The findings are that China does have a unique opportunity to change from the existing industrial Modern civilization to an ecological civilization and that existing accountability for sustainability evidence demonstrates that this change is already taking place.

Keywords: Episteme. Ecological civilization. Sustainability. Foucault. China

1. Introduction

This paper considers that the contingencies in place in China around sustainability are unique for a major emerging economy. Chinese actors in the sustainability network are dominated by government, not corporations, and the links to ancient Chinese philosophy, whilst not immediately apparent, do persist. To study this situation, this paper focuses on providing both theoretical insight and empirical findings to answer the question – "Can China move to new accountability for sustainability based on ecological civilization?"

The paper first provides a brief review of literature and previous research on: 1) Foucault's concept of episteme change and the contingencies leading to such change (Foucault, 2002 [1966]) in his monograph – "Les Mots et les Choses"; 2) recent extensions of Foucault's ideas in the sustainability sphere (Birkin and Polesie, 2012); 3) the concept of accountability (Gray et al., 1996); and, 4) the Chinese government policy on ecological civilization (Tu, 2013, Wang et al., 2014) including its links to ancient philosophy. The methodological viewpoint of the researchers is briefly discussed and the mixed methods employed in the research are described. The paper then goes on to a discussion of the contingencies and actors in the Chinese sustainability network based on the research carried out by Margerison (2010, 2016). The empirical findings summarise the research carried out on the reporting by Chinese provincial environmental protection agencies which, it is argued, represent an accountability for sustainability that has been little explored in previous research. Finally there is a discussion around the research question on new accountability for sustainability in China.

There are at least six different theories that can help to explain why change takes place in society: Realism (Bhaskar, 1978); Paradigm Shift (Kuhn, 1962); Structuration Theory (Giddens, 1991); Post-Modernism (Lyotard, 1993); Episteme change (Foucault, 2002); and, Modes of Existence (Latour, 2013). The episteme change theory of Foucault has been used in this study since it provides a detailed analysis of "Modern" which enables a meaningful comparison with Chinese thought.

Foucault (2002) argued that the human sciences change and develop over time as one episteme changes into another. For example he identified in the Classical episteme (1650-1800) disciplines of grammar, natural history and the science of wealth and in the Modern episteme (1800 to the present) disciplines of philology, biology and political economy (ibid. p224). Foucault (2002 p183) explained an *episteme* as: "In any given culture and at any given moment, there is always one *episteme* that defines the conditions of possibility of all knowledge, whether expressed in a theory or silently invested in a practice." Birkin and Polesie (2011) interpreted Foucault's notion of an *episteme* as the possibility of knowledge - what knowledge makes possible - the consequences of which define an age. So Foucault (2002) was able to identify different epistemes and what transformations could be attributed to episteme change. He noted that a change in episteme introduced a new ordering of knowledge and undermined the credibility of the prior episteme (ibid.).

Based on Foucault's (2002) theory of episteme change, Birkin and Polesie (2011) argued that there is the possibility of episteme change, from Modern to what they called Primal, taking place now. The Modern episteme (since 1800) is based around abstract, anthropocentric, logical belief systems and, they argued, has led to unsustainable development based on consumer-driven capitalism. The possible "Primal episteme" is based on the knowledge of things as they are created – i.e. a knowledge of primal processes that is now provided by scientific studies (ibid.). Hence at the centre of the primal episteme is empirically grounded science such as thermodynamic dissipative structures (Hammond, 2004), with accompanying developments in mathematics such as chaos theory (Gleick, 1988). This in turn leads to new metaphysics and a life-centred morality with Nature seen as active and self-regulating (ibid).

In this paper "accountability" is used to describe all techniques, including accounting and reporting in both calculative and narrative forms, by which an organization gives an account of its activities to those people and groups that have a right to that information. This definition is based on work by Roberts and Scapens (1985), Gray et al. (1997), Staubus (2003), Kamuf (2007). The "organisation" in this paper is a provincial government in China. Typically accountability information in the accounting for sustainability area has comprised both calculative and narrative (Kamuf, 2007). Calculative information is interpreted to mean information using accounting numbers including techniques such as Full Cost Accounting (Bebbington et al., 2001) and Ecological Foot-Printing (Wackernagel and Rees, 1996); whilst narrative information is based on words such as sustainability reporting on environmental aspects and impacts and the measures in place to manage the environmental aspects.

In moving to a discussion of ecological civilization it should be noted that Birkin and Polesie (2011) developed their notion of a primal episteme independently of the changing government policy in China, but were heavily influenced by the persistent metaphysical continuum in China based on the three ancient philosophies of Buddhism, Daoism and Confucianism. These philosophies, it has been argued (Pan, 2011), have created an ecological wisdom of the ages based around ideas of harmony between heaven, man and nature (the earth); reciprocity; all under heaven (Tianxia in Chinese); and, an active self-regulating nature that are still influential in China today.

Senior Chinese government figures (Pan, 2011) from 2007 outlined the concept of ecological civilization (sometimes called eco-civilisation) with harmonious society being incorporated into the rhetoric. Oswald (2014) noted that in 2007 at the Seventeenth National Congress of the Communist Party of China, Party General Secretary Hu Jintao announced a new model of growth incorporating "ecological civilization" to replace the old unsustainable industrial model "industrial civilization". It has been noted that whilst it created unprecedented levels of material wealth, the industrial model of development, based on high levels of resources and energy consumption, also brought serious pollution and ecological destruction to the industrialised world (Ma, 2007). He further noted that global capitalism had transferred the most polluting, resource-intensive and high-risk manufacturing industries to developing countries (ibid.). This had allowed developed countries to alleviate the pressure on their own environments without making any changes to their model of growth (ibid.). In this context China developed its industrial economy at the expense of heavy environmental degradation which was seen to be unsustainable (ibid.).

Ecological civilization was enshrined in the 12th five-year plan (2011-2015). The plan in translation stated: "In transforming the economic development mode, the importance of building a resource-saving and environment-friendly society should be stressed to save energy, reduce greenhouse emissions and actively tackle global climate change. We should develop circular economy (sic) and low carbon technologies. Through striking a balance between economic development and population growth, sustainable development will be enhanced (BritishChamber, 2011 p3)". In terms of resource conservation and environmental protection the Plan incorporated targets for: maintaining farmland reserves; cutting water consumption; increasing the water efficiency coefficient in agricultural irrigation; increasing the proportion of non-fossil fuel resources use in primary energy consumption; and, reducing energy consumption and CO2 emissions per unit of GDP[2] (ibid.).

2. Methods

Methodologically the research on which this paper is based on an interpretivist research philosophy and the ontological (relativist) and epistemological (transactional or subjectivist) stances that support that philosophy. Fundamentally the research sees reality as being subject to interpretation by the researcher, rather than an objective reality that can be examined in terms of, for example, causality - since it is a world of contingencies and actors where surprising things happen that cannot be explained causally. In terms of methods the empirical research on which this paper is based has included interviews, case-studies and surveys so as to discover what accountability for sustainability responses have been and are developing in China and the attitudes of Chinese accountants and environmental officials.

3. Results and discussion

The findings are analysed firstly in terms of the contingencies as accidents of history (Foucault, 2002)) and secondly in terms of actors or "actants" using Latour's (2005) "Actor-Network-Theory" methodology[3]. It is the basis of this paper that in China the contingencies in the sustainability sphere are unique and that the interactions of the actants can lead to the change to ecological civilization mooted by government in the last ten years.

From the data gathering, observation and literature in this research the contingencies in the Chinese sustainability sphere are represented diagrammatically as follows:

2 Energy and Carbon Dioxide intensity

3 Actor-Network-Theory is interpreted to be a methodology whereby in a particular field there are identified the key actants and that these actants form a network and the interactions between the actants lead to unpredictable outcomes.

Figure 1 Contingencies in place in China that could lead to episteme change and hence changes in sustainability accountability

Each contingency is now discussed and the data to support it is outlined:

Imperative for change – this is supported by documentary evidence from Chinese newspapers and also observation during visits to China. Statistics about the number of people who die from respiratory diseases are also frightening – a recent study found that nearly 4,500 people die in China each day from diseases related to air pollution (Phillips, 2015).

Strong metaphysical continuum – from ancient philosophy ideas of a life-centred morality, harmony and reciprocity – away from anthropologization[4] – this is supported by the interviews and surveys carried out with Chinese accountants, Chinese accounting academics and Chinese accounting students. In the interviews in most cases the interviewee professed strong views based on Chinese philosophies[5]. In the surveys, questions about philosophies and about attitudes based on those philosophies scored highly. In most cases there were strong correlations between high scores for philosophies and high scores for the attitudes to the environment based on the philosophies.

Invention linked to new science – this is supported mainly by textual evidence with China leading the world in research into and production of non-fossil fuel energy. China is a world leader in renewable energy investment (based on 2013 figures of $56.3 billion spending on wind, solar and

4 Man (or humans) seen to be at the centre of all things – both the subject and object of all actions. Foucault referred to this as epistemological man (Foucault 2002).

5 Primarily Confucianism, Daoism and Buddhism

other renewables (Perkowski, 2014)) and this demonstrates the embracing of new science in this area. In this study one of the case study companies was installing thermal pumping to provide heat energy in its factory and offices and assessed the benefit in terms of tonnes of coal saved.

Strong centralized single party government – strong single party government with a long-term outlook and the ability to make policy work is evidenced by the CPP five year plans and the great progress made in China since opening up under President Deng. Its recent pronouncements on ecological civilisation are a clear indication that China's government is taking the need for change seriously. This is evidenced by its recent pledge that China will reduce carbon intensity by 2030. It aims to cut its greenhouse gas emissions per unit of gross domestic product by 60-65% from 2005 levels under a plan submitted to the United Nations ahead of crucial climate change talks in Paris in 2015 (Reuters, 2015). It has also pledged that its CO_2 emissions will peak by 2030 (ibid.). In fact carbon emissions may have peaked already in China, years earlier than its leaders pledged, according to a study co-authored by the world-renowned economist Lord Stern (Harvey, 2016).

Further it should be noted that the Chinese government's emphasis on ecological civilization may change as it is faced with growing economic and fiscal pressures. However, it is the thesis of this research that the imperative for change, linked to the other contingencies, will cause episteme change in Chinese society that will be unstoppable – regardless of the government policy of the day. Episteme change is not something that will come about as the result of government policy and the ecological civilization policy since 2007 is a manifestation of episteme change taking place rather than the driver of that change.

Moves away from specialization – the interviews and the surveys showed that the Chinese accountant of today (and tomorrow in the case of the accounting students in this study) has an interest in sustainability and the accountability around this. This demonstrates that accountants have moved away from narrow specialization in traditional accounting. Specifically accountants were found to have much broader remit including sustainability accountability and were strongly influenced by Chinese philosophy. All the accountants interviewed exhibited personal philosophical values on environmental matters and these were often rooted in ancient Chinese philosophy. The surveys provided more evidence with a high proportion of Chinese accountant respondents identifying the influence of Chinese philosophies and their attitudes to the environment based on the philosophies as strongly agree or agree. So, the evidence from this research shows Chinese accountants strongly influenced by Chinese philosophy. This showed a linkage between "People" and "Culture" in the diagram on page 4.

In terms of involvement in accountability for sustainability by their organizations the situation was similar to existing research, with involvement and championing of accountability for sustainability by accountants still patchy. There was a sense from the interviews that companies and their accountants were waiting for government or Chinese Institute of Certified Public Accountants (CICPA) to introduce new accounting standards for sustainability – they were waiting and watching. This was the same view at CICPA where officials were again watching and waiting, which suggests that the two groups were both waiting for government and that the emerging ecological civilization policy may provide the impetus for change in accountability by organizations.

Also from the research the following (not necessarily full) list of actants in the Chinese sustainability network is presented:

1. Companies and their accountants
2. Human society (made up of individuals in their families)
3. Government (1) central government of the Chinese Communist Party
4. Government (2) Ministry of Environmental Protection (MEP) at provincial and local level
5. Government (3) local government – particularly the finance departments
6. Scientists
7. Nature (with all the non-human flora and fauna)

8. Chinese Institute of Certified Public Accountants (officials)
9. Modern day philosophers interpreting ancient Chinese philosophy
10. Pressure groups or non-governmental organizations (NGOs).
11. Students and academics of accounting and finance.

The key interactions between these actants were identified from interviews and policy documents to be: 1) the interaction and power of government at all levels on all the other actants with influence over accountability responses – companies and their accountants; CICPA; and, MEP at local level; 2) the interaction of modern day philosophers and the ancient traditions that they are interpreting with all the human actants – the interviews and surveys provided evidence that the ancient philosophies are still highly influential in thinking about the relationship of humans to nature; 3) the NGOs in the sustainability sphere interact with the human actants and also make the position of the actant nature stronger in the network through the deep respect for it by the other actants.

The paper now goes on to look at accountability responses already taking place in China. Much of the existing research on Chinese responses to accountability for sustainability has been based on corporate responses (Birkin, 2007, Chan and Welford, 2005, Du and Gray, 2013, Gao, 2009, Guo et al., 2008, ICAEW, 2007, Moletsane and Margerison, 2009, Patten et al., 2015, Xiao, 2006). This study extends this analysis to political regions which are based on Chinese provinces and provincial environmental protection agencies.

There are 31 provinces and autonomous regions (AR) in mainland China. A review of all these provinces and ARs was carried out and it was found that they all produced an annual report of environmental protection and in most cases had been doing so for many years. The earliest reports were for 1995 and all had produced a report for 2014. These reports were in Chinese with no English translations provided.

For the purposes of this preliminary research project one province – Liaoning - was selected and its recent reports analysed around environmental themes and some of the trends of language used and statistics analysed. Liaoning was selected because its reports were provided to the research team by an official of the local government during a visit to that province. Clearly a more in depth review and analysis of more provinces' reports is necessary before patterns of reporting across China could be identified. As this paper only presents findings from one province it makes no claims to representativeness and acts only as a preliminary study. The reports were translated by the Chinese member of our research team and in this case no second translations were carried out, so the findings must be taken on those terms – rather to generate interest and provide themes for further research into accountability for sustainability in a Chinese setting.

In translation the Liaoning reports have been titled "Environmental Situation of Liaoning Province" and were prepared by the Ministry of Environmental Protection (MEP), Provincial Environmental Protection Agency (PEPA). Of particular interest in the context of this paper's focus on "ecological civilization," for each of 2103 and 2014 the report was subtitled: "Strengthen the construction of ecological civilization". Also the 2013 report specifically referred to the fact that ecological civilization reform had started, leading to the setting up of an ecological province.

For the reports from 2010 to 2014 statistics were provided on the following areas: ambient air; precipitation; urban centralized drinking water source areas; reservoirs; offshore sea area; noise pollution of road traffic; ecosystems; and, emissions status. The range of statistics provided was very wide and for the purposes of this paper the important thing to note is that they represent the results for the whole province – state, companies, public. There is no indication as to how the statistics have been gathered and there is certainly no attestation or audit of the figures by an independent party. In terms of accountability the following matters were disclosed:

- assessing the number of cities and towns with nitrogen dioxide conforming to an MEP standard;
    - acid rain frequency in cities;

- water quality in reservoirs and in offshore sea area;
- decibel levels of road traffic;
- percentage of the province area of excellent; good or standard ecological quality; and,
- carbon-dioxide emissions in tonnes and reductions each year from a 2010 base.

None of these statistics are particularly innovative, but as a whole the package of statistics shows a province taking a very close look at its environmental aspects – a sense of provincial ecological responsibility.

Much of content of the reports was a review of the work of the local Environmental Protection Bureaux (EPB): environmental monitoring; complaints handling; law and policy; public participation; global cooperation; technology and service; supervision management; information publications and petition acceptance; environmental publicity and education; environmental development; environmental industry; special treatment; environmental inspection; environmental safety; environmental plan; environmental legislation construction; environmental policy; and, environmental management. The wide range of activities reported on give the impression of a PEPA that seeks to be accountable for all the activities in the province and has moved towards this in the depth of its disclosures.

4. Conclusions

Foucault's insights into episteme change help to understand sustainability accountability in a Chinese context and to represent findings in a new development model based on contingencies or accidents of history. This model has been explained with regard to a transition from the modern industrial civilization to an emerging episteme represented by the ecological civilisation concept now adopted by the Chinese government.

The contingencies in place and the interactions of the actants in China present a unique opportunity for episteme change to ecological civilization. Moreover, it has been identified that this change is already taking place and that the government policy is a manifestation of that change. In terms of accountability responses, earlier published research has shown that big Chinese companies have moved into sustainability-type reporting along the same lines as their Western counterparts. For example careful study of the 2008-2013 CSR reports of a major Chinese steel conglomerate during Margerison's (2016) research showed an engagement with concepts such as Life-Cycle Assessment (Liu, 2007, Finnveden et al., 2009). This paper has concentrated on the reporting by provincial environmental protection agencies of the Ministry of Environmental Protection. The reporting has been examined in a preliminary study to find out its extent across the 31 provinces and its content by reviewing the reports of one province over a five-year period (2010-2014), with the strong impression gained from the evidence of provincial ecological responsibility.

The conclusions overall are that China does have a unique opportunity to change from the existing industrial Modern civilization to an ecological civilization and that existing accountability for sustainability evidence demonstrates that this change is already taking place.

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A Study on Culture-specific Water Protection Service and System Design for Qinghai province

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Abstract

This paper is concerned with developing a new strategic model for a water quality monitoring service, and a system for water protection in Qinghai province, the source of three major rivers, the Yellow, Yangtze and Mekong Rivers. The villages of Qinghai province are facing rapid urbanisation and modernisation, which has caused various social and environmental problems for the Tibetan minorities who are the majority of residents in Qinghai. There is a demand for a change in the strategy of environmental protection, one reflecting more of the local mainly nomadic culture, which is strong and much more dominant here than other Chinese province.

The aim of this paper is to explore the relationship between local culture and the water protection system. The research hypothesis is that a 'water protection' issue is not only related to the water quality itself, nor is it simply a matter of technology, but also lies in the social and cultural system. Environmental policy and development strategy should be connected, and develop new alternative strategies that contain social sustainable values.To build and test the new strategic model, based on above hypothesis, this paper is partly the result of workshops and interviews with local residents. To understand water quality monitoring, this has been written with the collaboration of an engineer team, and made test visits up stream of the Yellow River and Yangtze River. Out of the analysis and action research process, this paper has extracted the key factors of the proposed model. This paper shows the each step of process in developing the strategic model.

The main feature of this strategic model is in its interdisciplinary hybridity that is the combination of science engineering technology and local culture. It is also based on social links and the participation of local residents, as well as reflecting regional unique culture and lifestyle. It shows how design thinking can combine two different poles, science technology and culture by using social links and human participation, and create a comprehensive mechanism within this water protection system. This will contribute to re-evaluate the impact and usage of social sustainability in environmental strategy and local collaboration.

Keywords: Culture-specific environmental strategy, Water protection service and system , Local residents participation, Design-led policy innovation

1. Introduction

1.1 Water protection in China

In recent years, there has been an increasing awareness of, and concerns about , water pollution in China as well as globally. New approaches to achieving sustainable exploitation of water resources have been developed and tested by many governments and independents organisations. However, policy statements regarding water pollution control found within a legislative framework, and is usually addressed in connection with the establishment of environmental legislation and action plan.

In this paper's research, these situations are regarded as a ground for needs, and investigating alternative solutions for sustainable development in water protection strategy.

Since 2000, both the country and the public have placed increasing emphasis on the problem of pollution. Environmental issues have become a major barrier to China's economic development, human well-being, quality of life and public health. Increasingly tough policies on environmental governance have been released, and considerable progress has been recorded in recent years.

According to the State Council Water Conservancy Department Report (2010-2012), there are 1,580 rivers(surface size over 1000 million km^2 in China. Contamination of water is a cause for serious concern, making it this pollution issue the most focused upon in China. To prevent and solve the water pollution, the Chinese government has established a series of policies and regulations. Although increasingly industrialised China remains primarily an agricultural society, and a large proportion of population is engaged in agriculture.

There is little experience with, or management of tools for non specific sources of pollution in China, and the database for this is still under construction. The conseversation measures for nonspecific sources in 11th 5-Year Plan were mostly concerned with policy support and trial demonstrations. Although it is difficult to control nonspecific source pollution, enormous sums of money have been invested in research and demonstration projects. However, one of the difficulties is that such pollution control measures are not yet economically efficient, and the benifits of the technology needs to be promoted to the public. (Liu, 2012) (Liu, Jian. Systematic Mechanism Design of Long-term Agriculture Non-point Source Pollution Control [J]. China Population, Resource and Environment (2010) 20 (3) .

The most important regulation related to water environment management is the Rules for Implementation of the Law of the People’s Republic of China concerning the Prevention and Control of Water Pollution, passed in 1989 and revised in March 2000. In this regulation, monitoring and management, surface water pollution control and ground water pollution control are explained in detail. This regulation has significance because some general rules are stipulated in it and many new environmental policies were derived from them. Other regulations concerned with water environment management: 1) Implementation of the Law of the People’s Republic of China on soil and Water Conservation; 2) Implementation of the Fisheries Law of the People’s Republic of China;3) Implementation of the Law of the People’s Republic of China on soil and Water Conservation;

Table 1 The five Grade of Water Quality in China

Grade	Utility and Protection Target
I	Water source;National Nature Protection Zone
II	Domestic drinking water source (Class Ⅰ); Rare aquatic biology habit; Egg-laying site for aquatic life forms; Feeding and preying site for baby fishes.
III	Domestic drinking water source (Class Ⅱ); Hibernation site, migration route and breeding site for aquatic life forms; Swimming site.
IV	Water use for industry; Environment use where water does not touch the human body
V	Agriculture use; Scenic body of water

Soure: Chinese National Standard GB3838-2002

<Table 1> shows the water standards which divide the water quality into five grades, from ‘Grade I’ to ‘Grade V’. In this standard, ‘Grade V-’ is used to designate water quality which even does not reach the Grade V. The table below presents the Chinese standard. (Ge et al. 2012)

In 2009, Chinese government monitored the river quality in 408monitoring points of 203 rivers. Of these, 57% reached the standard grade I to III and 24.3% were grade IV and Grade V.

Unfortunately 18.4% were under grade V. (Ge et al. 2012)

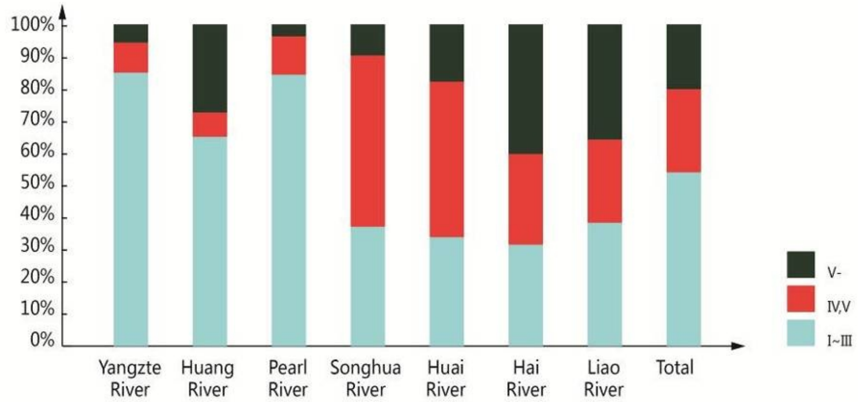

Figure 1. Water quality monitoring of seven major rivers in China

Source: http//jcs.mep.gov.cn/hjzl/zkgb/2009hjzkgb/201006/t20100603_190435.htm

Figure 1: the most contaminated rivers were Hui River and Hai River following by Liao River. Other rivers like Yangzte River, Huang River and Pearl River are not included in this high contaminated group is that their starting point is in the far west of China, where the area is and mountainous. In terms of water protection there is a need to closely monitor these relatively un-contaminated river areas, and proactively prevent pollution, and the factors that cause it.

1.2 Reasoning

Although the Chinese government and other governments already have standard international co-operation and research on water pollution control, there is still a great need for concerted planning and action at the innovative and advanced policy level.

Furthermore there are huge areas in China, especially in the west where many river sources are located, which remain as a no mans land. Population density is low, sometimes non-existant, and often these remote areas have no roads for cars even where villages exist.Considering the above situation, the strategy of water protection should reflect the reality of policy development direction, and the process of strategy formulation. Three major river start in the Qinghai area, and it is a main source of water for a large part of China. Because of its altitude and geographical location, near to Himalaya Mountain, it is often called ‘the roof of the world’. In the past decade Qinghai has suffered three massive earthquakes , in Wenchuan(2008), Yushu(2010) and Yaan(2013), affecting all Chinese people, with echoes in the to outside world. The reconstruction and modernization of the affected towns and cities, and the building of new infrastructure has been carried out at unprecedented speed, however, obviously there have been conflicts between nature, culture, and traditional art protection.

1.3 Qinghai National Water Protection Area

Yushu City located at the source region of three rivers (Yangtze River, Yellow River and Laicang River) in Qinghai-Tibetan Plateau, which rising average 4200 meters above sea level, it is known as one of the highest located cities in the world.

The Source Region of Three River Nature Reserve Region together with Hoh Xilinx Nature Reserve Region cover autonomous prefectures in Qinghai, have been long reputed as “Source of Rivers”, “Ancestor of Famous Mountains”, “Land of Yaks” , “County of Songs and Dances” and “ Water Tower of China”. Yushu region has many varieties of tangible cultural heritage, their content and forms are so abundant that they are praised of jewels of ethnic flavor by Zang folks. Nowadays, many cultural elements have made UNESCO’s list of national tangible cultural heritage, such as the legend of King Gesar, Yushu folk songs and costumes, Nangqian black pottery, Yushu Zang knife and Yushu horse race. According to Chinese government’s water monitoring test the river water grade in this area is level 1, best water quality in whole China and designated as a national protection area.

Figure 2. Landscape and Culture in Qinghai

Owing to climate and man-made factors, The Source Region is facing difficult challenges: the capability of water maintenance is one. Numerous lakes and wetlands shrank, and even ran dry, also there are serious problems of internal fluidization and salinization In this way large areas of wetlands have vanished, biodiversity is badly impacted, also with the foundation of sustainable development of grasslands… Meanwhile, post-disaster reconstruction and the construction of settlement areas in Yushu, ahave proceed at amazing speed, changing basic forms of Zang society, which means traditional “nomad culture” with religion-oriented society organization will be confronted with new historical changes. Accordingly, how to react the changes both in natural and cultural way at the same time, proves to be an urgent and challenging task.

1.4 Research Hypothesis

With above background, this paper proposes an alternative strategic direction which can be supportive of the local culture, and create an economic and sustainable system of water protection in river source area, where population density is usually low, and sometimes non-exist.

The aim of this research is to investigate the relationship between local culture and water protection activity, including river water monitoring in Yushu area in Qinghai province. Then, to develop an alternative site-specific strategy through the research process.This will provides the framework for water protection strategies for various other sites which are in physically in remote areas, and culturally isolated and difficult to communicate with.

This hypothesis is based in interdisciplinary design thinking that problems and problem solving factors not only exist in a water protection system, but also in social and culture issues and systems.

This research raise some questions, listed below as five issues.

1) What kind of water protection activity exist, if any. Then how can this be linked with the new strategy of this research.

2) What kind of local culture is in this area and how related with these kind of environmental concepts and activities?

3) How much present lifestyle is related with past traditional culture and how this research can find the overlapping point and thread?

4) What kind of technology element can be introduced here and in what culture-specific forms?

5) Where is the sustainable point and culture value which can lead the technology?

As a benefit of this research, central and local government relevant body can use this strategy and model to develop and implement surface water protection strategies in Qinghai area or other remote area in China.

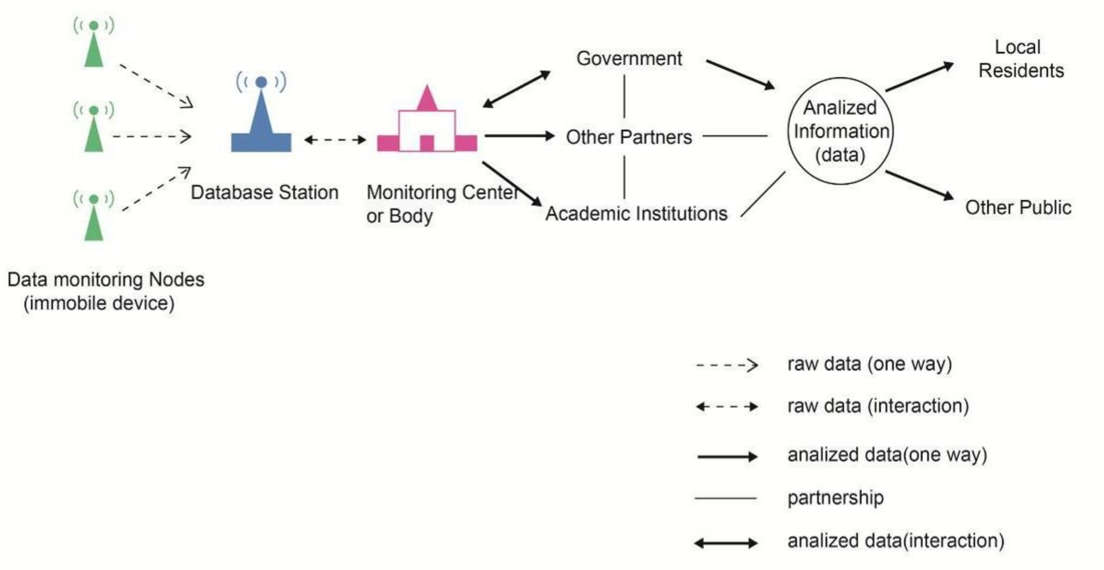

Figure 3. Analysis of existing non-interactive river water monitoring system

2. Methods

2.1 Research Methodology

Many case studies suggest that sustainable environmental protection requires the involvement of all stakeholders throughout the processes of policy making and implementation (Gbadesign and Ayileka 2000; Bewket and sterk 2002). Such participation is associated with increased mobilization, higher efficiency, better understanding and social cohesion, more cost-effective services, greater transparency and accountability, and strengthened capacity of the public to learn and act (Pretty and Shah 1997)

The challenges come from many ascepts such as the ongoing rapid economic growth, problems in the exisiting pollution control measures, and the dominating contribution of non-point sources (e.g., agricultural fields), for which control is more difficult than for point sources such as factories.

The existing environmental management system in the basin has not been well organized and cannot meet the requirements of the current socioeconomic development. The traditional management system is a legacy from the planned economy and generally operates in a sector-fragmented, command-and-control way.

Due to overlapping responsibilities, inadequate policy coordination, and lacking public involvement , it has ay best implemented inefficient countermeasures against the environmental problems and has even contributed to the environmental of new problems (Antunes and Santos 1999).A new management system based on the ideas of integrated environmental management (IEM) is expected to be established in order to correct this situation.

2.2 Conceptual Model of System Network

<Figure 4 > shows the visualisation of conceptual model. It divides the participants(nodes) as a four groups, from nomad village people near to the top the mountain to the city people.

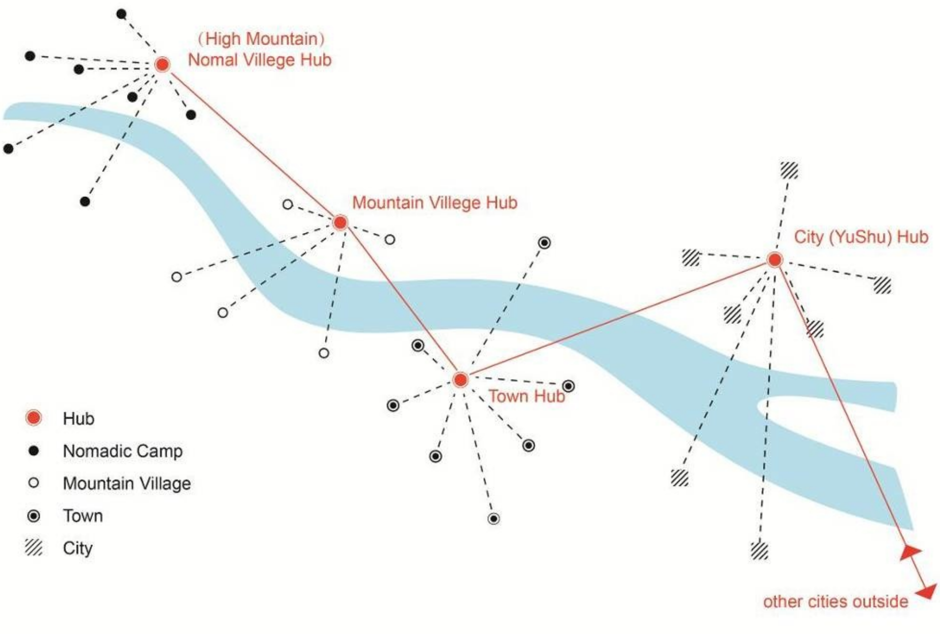

Figure 4 Conceptual Model of Source River Water Monitoring System in Qinghai

2.3 Process

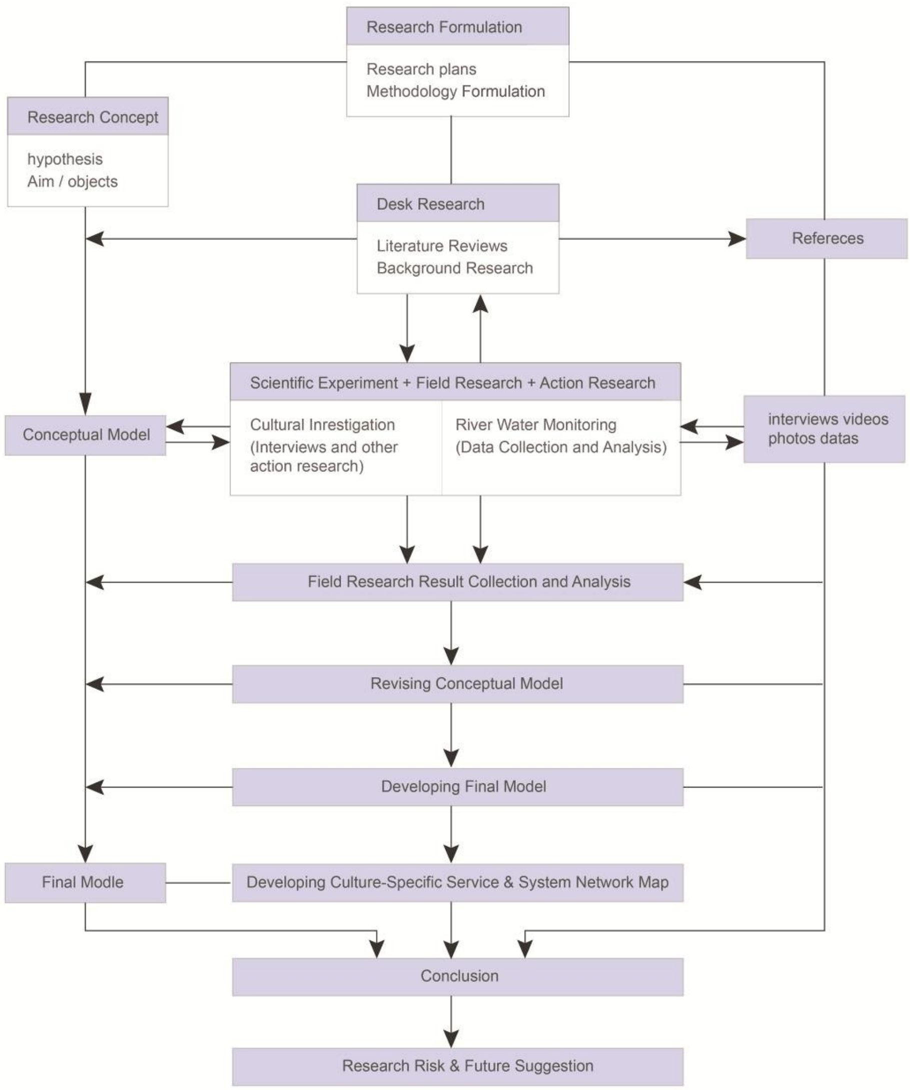

Figure 5 Research Process

The above diagram shows the process of this research. Since the interdisciplinary approach, which combines culture and science technology it s the key point of this research, and it is located in the centre of process

2.4 On-site Test Project Formulation

To gain practical value of research, this paper demonstrates organized on-site action research methodology.

Test Site Objectives.

The main object of organizing a test project is to asses the practicality and feasibility of conceptual model.

Target objectives are research into water ecology and water environment in YuShu, research into Yushu's water resource protection and community organizations, research into the development concept of a resource monitoring product with existing technology, and a design information database based on inspection data of water resource and service system.

Selection of Test Site

Locations were pre-selected through the two steps of discussions with local NGO and designers. One step was before the arrival at the Qinghai area, and at the next step. 30 sites were selected for onsite testing.

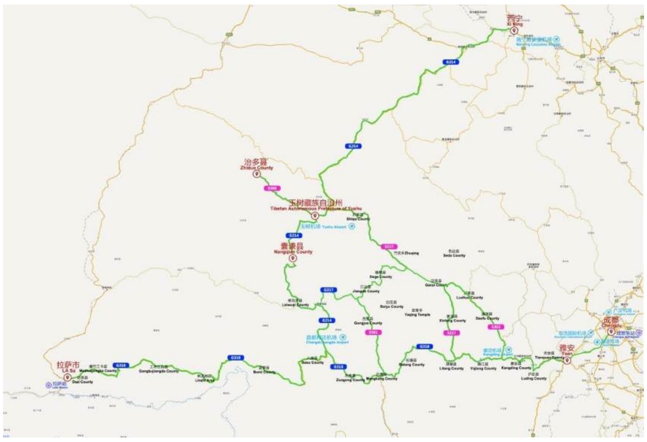

Figure 6. Test Project Location

Participants (Expert Groups)

In the process of on-site test projects, the research team met stakeholders and collaborates when the whole process of the conceptual model was explained.

The main research team consisted of international experts, designers and engineers from U.K, Korea, France, Italy and China.

It was organized in collaboration with local NGOs, internal and international, academic institutions, research centres and local government.

Period and Duration

The total period of research took one year, and on-site cultural research and technical data monitoring took 4 weeks of site visits. These were carried out in the summer season, due mainly to climate considerations. Also this coincides with the influx of outsiders whose contribution to pollution is a factor to be considered.

2.5 Test Project Process, Task and Divisions

There is a need to:

have a full understanding of the distribution of surface and ground water in the environment,

test basic chemical composition and content in the water environment.

research the basic elements in the local water ecosystem, including the aquatic plants, soil salinization, main pollution sources

record the influential elements to the water quality for labor productivity in this region.

Social aspects of water (religion and culture)

-Research the nomadic culture and the Tibetan herdsmen's religious beliefs, and it's relationship to water within nomadic culture

-Investigate the religious activities and it's influence in the process of water conservation.

Intelligent water monitoring product test

-Test relevant devices that have an interactive technology for the monitoring local water resources

-Discuss the entire system, combining existing monitoring data with artificial real-time measurement data

Figure . Test Project Process of Cultural Investigation

Cultural and social environmental research

-Research local culture, history and craft, such as the legend of King Gesar, Yushu folk songs and costumes, Nangqian black pottery, weaving and processing of Yak's velvet (leather)

-Document traditional music, fashion and handcrafts, making extensive use of video recording and sound recording.

-Investigate rural lifestyle, traditional water usage and wate disposal.

System Innovation design based on the culture

-Transformation of science and engineering thinking, building ecological models.

Carry out interviews. prepare and circulate questionnaires.

3. Results

3.1 River water quality monitoring

There were more than 30 trials of source river water monitoring, 20 to 25 of these were considered successful. In the process, there were various kinds of risks and barriers to overcome, altitude sickness, adverse weather and the remoteness of some areas. The sources of many rivers river are located in high mountainous regions at elevations of between 3,000 to 4,000 meters.

Figure 8. Test Project Process of Water Monitoring

In the water quality monitoring, 6 kinds of components of river water have been considered as an testing elements. Tested components were, water temperature,PH,dissolved oxygen,total dissolved solid, electric conductivity and salt content.

Table 2. Qinghai water quality monitoring data of river streams in YuShu area

Water Quality Monitoring Data of YU SHU JIANGYU									
No.	Data	Time	Place	Water Temperature	PH	Dissolved Oxygen	Total Dissolved Solid	Electric conductiviy	Salt content
01	17 Aug.	17:21	SanJiangYuan cenotaph	14.75	8.2	48%			
02	17 Aug.	18:18	ShaiJingTai	15.01	8.24	50.33%			
03	17 Aug.	19:42	Rapid river stream of ZhaQu	15.58	8.26	50.60%			
04	18 Aug.	17:35	Junction between GanDa village and GuoQing village	13.03	7.8	47.46%	218	627	210
05	18 Aug.	18:19	Entrance of water factory	13.03	7.8	46.86%	211	608	203
06	18 Aug.	18:54	Junction between ZhaQu river and DangDai village	13.10	7.7	49.40%	183	568	190
07	18 Aug.	19:20	Old buddhish college	13.73	7.8	50.27%	222	632	214
08	19 Aug.	18:06	Source of GaQu River	5.77	7.7	26.37	95	349	105
09	19 Aug.	19:40	Source of GaCaiJi	5.26	7.5	41.99	106	344	109
10	19 Aug.	20:04	Headwaters of GaDongCuo	6.85	7.2	40.72	163	507	164
11	20 Aug.	12:37	LongBao Lake	13.99	8.5	99.67	235	645	206
12	20 Aug.	14:48	Source of ZhaQu	11.82	7	30.17	196	759	255
13	20 Aug.	15:19	ZhaQu(Under the bridge of SuiDao River)	12.65	7.9	45.13	257	759	255
14	20 Aug.	15:43	LongYan River	12.84	7.9	43.19	144	452	150
15	20 Aug.	16:02	Dang QinGaDuo	16.54	8.1	84.11	140	409	137
16	20 Aug.	16:28	NaLong River	14.63	7.7	95.73	320	997	333
17	22 Aug.	11:09	Wooden bridge in entrance of ZhaRong village	8.67	7.91	72.23	348	489	160
18	22 Aug.	18:27	ZangBuQinGu(old big river)	13.67	7.8	66.56	189	578	191
19	22 Aug.	18:32	GanMu River	12.08	7.7	77.3	172	540	180
20	22 Aug.	19:09	DaMa River (upstream)	6.6	7.9	77.84	121	430	136
21	22 Aug.	19:52	XueBaoLong ditch	9.4	7.7	76.44	138	442	144
22	23 Aug.	11:04	DaAiQingGangMuJia	7.11	7.1	55.94	145	493	159
23	23 Aug.	13:00	KaMuQiu River	11.19	8	76.7	110	360	119
24	23 Aug.	14:18	GeQu River	10.29	8	133.44	144	461	151
25	23 Aug.	14:21	GeDa River	8.51	7.1	104.27	137	501	161

4. Discussion

4.1 Strategic Suggestions

As a result of test project, this research has arrived these strategic suggestions.

There is a need for:

-Local community participation as a main link in formulizing the water protection system

-A collection of comprehensive data and information at different geographic points on the river in Qinghai area

-To develop a mobile application this can work by icons and images

-The local environment protection network to form collaborative links with local temples and NGO ‘s

-Support from experts, relevant institutions and designers to develop interdisciplinary strategies

As Coplin (2010) mentioned, in participation project, the most important thing is designing and managing the balance between system and tool. Challenges, here, is how to integrate the internal angle based in cultural value such as attitude, languages, religion and lifestyle, with external angle based in scientific value such as economy and safety.

4.2 Sustainable Factors of Culture-specific water protection model

These (below) are the considered key factors in this research's conceptual model, the culture-specific water monitoring service and system. In the system model developed in this research, design plays a role in a strategic level and also at the project planning stage. Which means design is not only for problem-solving but also lies at the starting point of strategy formulation.

Factor 1. Site- specific Strategy

Geographically isolated locations, extreme weather conditions and high altitudes require site-specific strategies which reflects the local' environmental ecological condition. Without considering site-specific elements, it is unlikely that the strategy can succeed.

Factor 2. Culture-specific Service and System

There are various challenges and opportunities in the links with local culture.

In the test project, it was apparent that the local people actually had never been never educated about environmental policy, and some do not not speak Chinese. The main reason that they collaborated in the whole testing process was because of their ancient storytelling, or religious stories, matched with the river source protection theme.

Therefore there is a critical need to connect with local culture to gain synergy.

Factor 3. Human Participation

For many reasons NGO has been playing the role of local residents, because of lack knowledge and communication skills with the others. However, it is time to think about a new strategic shift, especially, in the area of Qinghai which has a unique culture and lifestyle, very different from outside and largely isolated by environmental features and an average elevation of 3,000 meters. They, the residents can play a key role as providers of local environmental data and information. They also can support a comprehensive data base of local geographic and cultural knowledge.

Public participation is still in its initial stages in the current environmental management system. In some sense, water environmental protection itself is still a government concern. The city residents, farmers, and even enterprises have generally been excluded from the planning and management processes. As a result, they have little idea of what has been happening to the environment, and the likely changes, the potential impacts on humans and the ecosystems, and most importantly, what they can do. Under these circumstances, it is difficult to expect the public to play a positive and effective role in environmental protection.

Factor 4. Mobile Links

According to the Chinese government's report (2013) half of population have smart mobile phones, and 90% percent use the phone for internet connection.

Mobile phone connection in China as web communication media is one of fastest growing phenomena, especially in Tibet, where often alternative methods of communication do not exist. The mobile phone has simply become essential, and in in remote areas it is a critical feature in being able to manage and communicate with the outside.

Factor5. Small multi-unit structure

This can be called as a modulisation and based in user contribution of contents. As Cass(2006) pointed out, this kind of user's contribution and participation can only work with web links in 21c internet world. This is the platform by which anybody can upload their own data and information, anywhere and at anytime. This is doing away with the existing structure of relationships between time and location, as well as the number of participants. As you see from Image 4, each single, data content from water quality monitoring by local resident contributes to the aggregated data.

Factor6. Community-based resource management

In contrast to centralized planning and authority, community-based resource management is a bottom-up approach that involves local resources users and community members in active management and responsibility for local resources. The bottom-up approach assumes that local users, if given responsibility for their resources will manage their resources in sustainable ways and enforce community-derived rules. Bottom-up approaches evolved in response to the failure of more centralized approaches and with the recognition that local management may be more effective than a top-down approach.

Community - based management is consistent with the tenets of co –management--described below--since government is always involved in the management process.

Factor7. Co-management of data collection management

Co-management or collaborative management incorporates both a top-down and bottom-up approach. It describes in reality most management processes by which governments (especially local governments) share responsibility and work together in dynamic partnerships. This collaborative process is based on the participation of all individuals and groups that have a stake in the management framework. Social, cultural, and economic objectives are an integral part of the management framework. Government retains responsibility for overall policy and coordination, while the local community plays a large role in day-to-day management.

Co-management also creates the opportunity to take advantage of scientific and technical knowledge (often from outside the community and local or traditional knowledge within the community). The former brings the rigors of the scientific method from government agencies and research institutions; the latter contributes site-specific and historical information, customary practices, and traditional values that add local experience and an important social dimension to the MPA planning process.The trend in MPA management is in fact to become more integrated across habitats and sectors, and more focused on community-based or local-level management rather than centralized approaches

Factor8. Interactive Platform

As the <Figure 8> below, the controlling mechanism and participatory mechanism interact to deliver or sharing contents of system.

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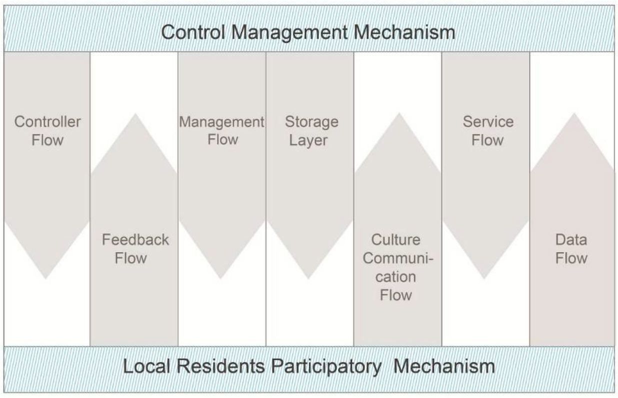

Figure 8 Conceptual Model of Source River Water Monitoring System in Qinghai

5. Conclusions

The project team will take three rivers' sources in Qinghai (Zhiduo County and Nangqian County) as bases for researching lifestyles and resources, especially investigating the heritages of these two traditional rural lifestyles.

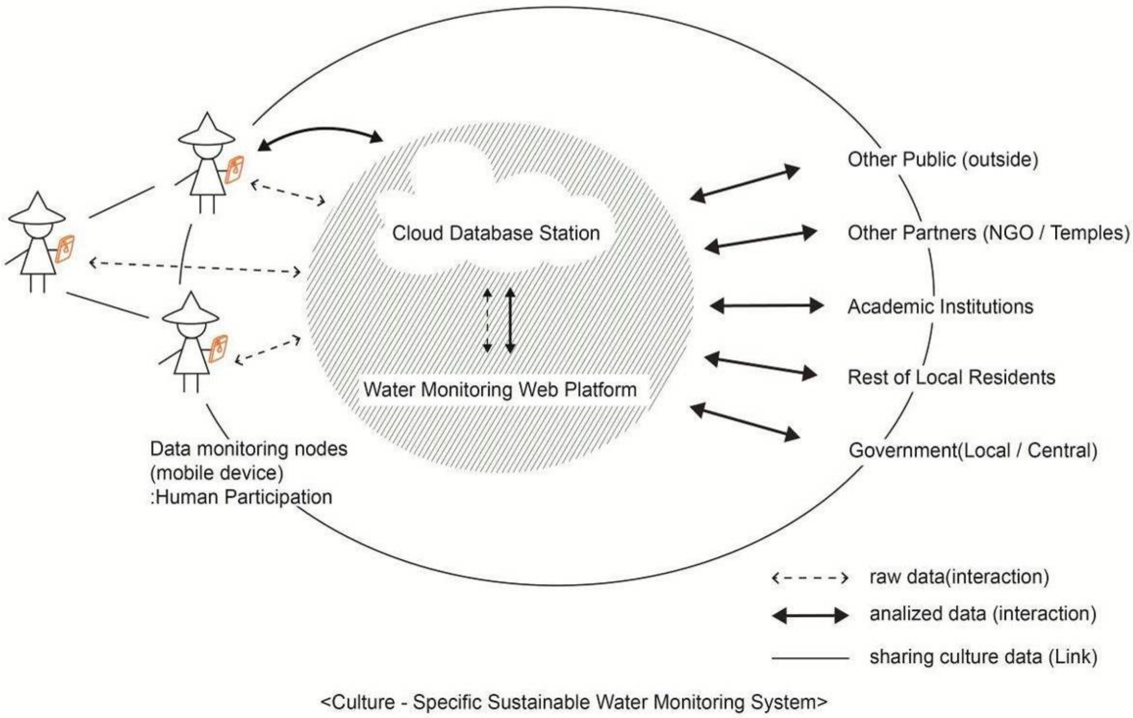

Figure 9 Culture-specific Sustainable Water Monitoring System

<Figure 9> shows and explains the system of culture-specific water monitoring strategy which is a main product of this research. Through the interactive links and local residents'' participation this strategy can bring social sustainability of water protection strategy as well as policy. It has a potential for strategies of water protection in source of rivers in Yushu of Qinghai province.

From the test project of water quality monitoring, this research found that surface river water quality is inevitably lies with the present life-style and culture. The hypothesis of this research was approved and tested. Summer season 's water quality in up stream river source area were in a good condition. The result from water quality monitoring of river water quality in Yushu area, Qinghai province, provide some degree of assurance of safe drinking water. however, all systems are vulnerable to potential contamination. Therefore, to minimise future treatment costs is to protect local culture and site specific strategies designed to protect and monitoring the upstream of river area.

This research provides innovative water protection strategy options available for local government or central organizations, involved in the development of policy and management of water protection.

The ultimate goal of this service and system, is to influence the environmental policy, and to provide strategy, and to contribute to the marginal region's sustainable development through understanding of cultural diversity. There are still some areas to develop and cover the unstable points of this system.One of urgent issues is 'education' which is needed for both sides, local residents and policy makers. Education here is, as mentioned in system map in the <Figure 9>,is not just environmental education it is also cultural education.

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Sustainable public procurement framework in the Brazilian federal public organizations

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Abstract

For years, the assumptions of the Theory of Systems began to be used to represent the many different organizational systems and their interactions with the external environment, including the subsystems of purchases of public and private organizations. The Stakeholder Theory is also developing a theoretical body consistent and applicable to the organizations and the problems related to sustainable development. In recent years, various public organizations, including the Brazilian, encouraged by the States, began to adopt procurement processes with sustainability criteria, in search of more sustainable patterns of production and consumption, commonly known as sustainable public procurement. It is observed essence, even if not formalized, that public organizations which practice sustainable purchases, use a framework with peculiar elements of requirements, processes, results, evaluation and interaction with the external and internal stakeholders. These particularities, although important to the advancement of the subject of sustainable public procurement, are little mentioned or described by the literature. The objective of this paper is to propose the main characteristics of a typical framework of sustainable public procurement in Brazilian public federal organizations. This is a case study of a federal Government of Brazil – a country of a great dimensions and an emerging economy. The data were collected through the research of literature and interviews with twelve Brazilian experts in sustainable public procurement, from the government, academia and practitioners. The analysis of the data showed that the activities inherent in sustainable public procurement carried out by the Brazilian federal public organizations can be better understood through the schematic representation of a framework, in which the performance of the main stakeholders, the main entries, transformation processes, results and feedback systemic are delineated. In relation to the stakeholders, the importance and the way of operation of the international organizations and the Government were emphasized. Within federal organizations the main system entries, classified as strategic, regulatory, and operational needs were showed. The processes of transformation of these entries were also analyzed, including activities related to the strategy, the standardization and the operationalization of sustainable procurement, in addition to training activities, common to the identified activities. The results of the system were also analyzed, with emphasis on two basic systemic outlets and its peculiarities: the "Buy" and the "Not buy". After, the actions of feedback for the improvement of the system were also highlighted. Finally, it is concluded that the Systems Theory and the Theory of Stakeholders provided important theoretical grounds important for the visualization and understanding of the elements of a typical framework of sustainable public procurement in Brazilian public federal organizations. This understanding can provide important theoretical concepts as contributions to the development of sustainable public procurement related issue. Additionally, the proposed framework can be used by the decision-makers for a better management of the performance of sustainable procurement activities carried out by the organizations, as well as to help the State to improve its public policy of encouraging the sustainable public procurement.

Key-words: Sustainable development; Sustainable production and consumption; Sustainable public procurement; Theory of systems; Stakeholder theory

Transport Planning in Brazil: a case analysis of current practice in considering environmental and social issues

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Abstract

The necessity to strengthen sustainability by promoting environmental and social issues in policies, planning and legislation, as well as in international agreements, has been recognized for some time. However, on many occasions, environmental and social values remain inadequately considered in decision making. This is the case in many developing and emerging economies where a perceived urgency to promote economic growth frequently comes at the expense of negative environmental and social impacts. This paper focuses on transport planning in Brazil, i.e. an emerging economy that over the last decade has been primarily investing in transport, energy and social/urban infrastructures, through the 'Growth Acceleration Programme'. According to Brazilian legislation the assessment of environmental and social impacts is compulsory only for projects with potential to cause significant impacts, thus leaving a gap in decision-making related to the integration to strategic levels. As a result, the process is subject to many conflicts and several confrontations may arise, usually reflecting aspects that do not concern the project level. While the necessity to consider environmental and social issues prior to projects has been well discussed in the literature, little is known about the extent to which it has happened in Brazilian planning. In order to answer this question, this paper analyses Brazilian transport planning through three aspects: legal context, institutional context and the consideration of environmental and social issues in transport policies, plans and programmes (PPPs). The results show that the need to protect and preserve the environment, to support a good quality life for people, as well as to promote sustainability are well established at the level of guidelines, both legally and within institutions. However, in practice, environmental and social issues are only marginally considered. The environment is usually synthesized in a single variable (e.g. 'greenhouse gas emissions'), and social issues are mainly referred to under the heading 'mobility'. Moreover, economic interests are prioritized in final decisions, overcoming environmental and social aspects even when a more comprehensive group of issues is considered. Whilst the guidelines to promote sustainability are recognized in the transport sector, the current "sustainability approach" is not sufficient and there is room for improvements within legal, institutional and practical contexts.

Key-words: Environmental issues; Social issues; Planning context; Brazil; Transport.

1. Introduction

The necessity to integrate environmental and social aspect in decision making and to foster sustainability has been discussed and recognized worldwide (Church, 2015). The concept of sustainability requires environmental, social and economic dimensions to be integrated (Healey and Shaw, (1993). However, sustainable planning is not yet recognized as an acceptability criteria of international agreements (as it is for projects) and mainstreaming it may contribute to the "transition to sustainability" (Church, 2015, p 61).

Currently, there is a gap between rhetoric and practice, as the consideration of environmental and social issues in planning and decision making is often not adequate and marginal to economic interests (McManners, 2016; Montabon et al., 2016; Stoeglehner and Neugebauer, 2013; Fischer, 1999a). Despite the fact that improving practices within planning and decision making is not an easy task (McManners, 2016; Stoeglehner and Neugebauer, 2013), it is of fundamental concern, especially considering that without the adjustment of the many issues to be considered within planning systems, environmental and social issues will be continuously challenged (Healey and Shaw, 1993).

In many developing and emerging economies, a perceived urgency to promote economic growth frequently comes at the expense of environmental and social interests. This is also the case in Brazil, an emergent economy where the political model favours economic interests of dominant groups rather than public policies (Ebrahim, 2008), at the expense of social rights. The country's development in recent years has centred on infrastructure and sectoral investments, including transport, one of the main areas of investment under the National Growth Acceleration Programme.

Environmental and social impacts in Brazil are mandatorily assessed at the project level, i.e. at the moment when many conflicts and controversies arise, especially when it comes to big infrastructure projects. However, here conflicts frequently arise that do not refer specifically to the project, but to higher levels of decision making. This includes questions on the choice of the transport mode and the approach used to solve transport problems (see Fearnside and Graça, 2006; Fearnside, 2007; Sánchez and Silva-Sánchez, 2008; Fischer, 2006). In this context, it has been suggested that many environmental impacts are results of government policies, plans and programmes or legal instruments that fail in adequately consider environmental issues (Milaré, 2005).

Whilst the necessity to consider environmental and social issues in planning is extensively discussed in the literature, little is known about the extent to which it has happened in Brazil. Aiming at exploring this gap, this paper reports on practices in the transport sector, which is of key importance to the country's economy (Arvis et al., 2010; Headicar, 2009) and which has the potential to significantly affect society and the environment (Vasconcellos, 2013).

2. Methods

Intending to analyse the extent to which environmental and social issues have been considered in transport planning in Brazil, this exploratory research is based on the review of transport planning system, analysing contextual aspects that influence the planning system, according to the professional literature – legal framework (Healey and Shaw, 1993; Selman, 1995) and institutional framework (Sager, 2001; Selman, 1995) – and practical context, comprehending policies, plans and programmes that compose the planning framework.

The professional literature also points to other relevant aspects that influence the effective consideration of environmental and social issues in planning (e.g. political interest and power relations (Healey and Shaw, 1993; Kørnøv and Thissen, 2000). However, the research underlying this paper was limited to formal aspects of the planning system that are expressed in official documents (e.g. laws, planning reports; Fischer, 2002).

2.1 Selection of cases

The Brazilian government is organized at three administrative levels: national, state and municipal. Because all three levels have competences with regards to transport issues (Brazil, 1988), in the research underlying this paper we investigated the three levels in order to obtain a comprehensive picture of the planning framework. However, as the institutional structure of transport sector differs significantly amongst the states and municipalities, it was necessary to focus on one state and one city.

Thus, Sao Paulo State and Sao Paulo city were chosen as case studies because of their uniqueness regarding transport, as transport infrastructure and services are mainly concentrated at these levels (Braga and Castillo, 2006; Medeiros, 2014).

2.2 Legal framework

To understand the legal framework applicable to the transport sector at national, state and municipal levels, legislation regarding transport issues was considered. Relevant legislation was identified based on legislation databases of federal[6], state[7] and municipal[8] levels, using keywords search, comprehending the following terms: transport, transport policy, transport plan, transport planning, sustainability, environment, mobility, accessibility, social responsibility. All legislation was analysed, aiming at identifying the sector's responsibilities regarding the consideration of environmental and social issues in transport planning (e.g. guidelines for planning and planning instruments).

2.3 Institutional framework

Aiming at analysing the institutional context for the incorporation of environmental and social issues in the transport sector, this part of the research includes the institutions that currently compose the institutional structure of transport planning at each administrative level (Figure 1). The institutions were analysed based on the information available on their websites (including reports and other documents that can be accessed through the websites), understanding that this information represent the official and public position of the institutions.

All identified information regarding environmental and social issues was analysed qualitatively and codified according to how these issues are presented: as a formal policy, an institutional purpose or value, an instruction, or an action. Moreover, the instructions and actions identified were codified based on their focus, totalling three groups: focus on institutional management, on planning issues, on projects, on education activities, general instructions, and other actions.

2.4 Planning framework: transport policies, plans and programmes

In order to analyse the consideration of environmental and social issues in planning practice, transport policies, plans and programmes from national, state and municipal levels were selected in a non-probability manner (as the entire population of PPP is not known), based on the following three criteria: it should be a policy, plan or programme related to transport services or infrastructure, elaborated by or with the participation of some transport institution, and the document should be accessible. To identify and access these PPPs an exploratory search was conducted on websites of transport institutions. Furthermore, a literature review was conducted and transport institutions were consulted.

A total of 43 PPPs were identified for the national, state and municipal levels. For 19 of these documents were accessible, including four policies and 15 plans. These compose the sample analysed in this paper (Table 1). The sample includes two plans that already have more than one version (as the result of a review process): the National Plan of Transport and Logistics (version from 2007, 2009 and 2012) and the Sustainable Transport Plan (version from 2010 and 2013). Each version of the plans were analysed separately, based on the content of the associated reports.

[6] Federal database available in: http://www4.planalto.gov.br/legislacao
[7] State database available in: http://www.al.sp.gov.br/leis/legislacao-do-estado/ and http://www.legislacao.sp.gov.br
[8] Municipal database available in: http://www.camara.sp.gov.br/atividade-legislativa/legislacao/

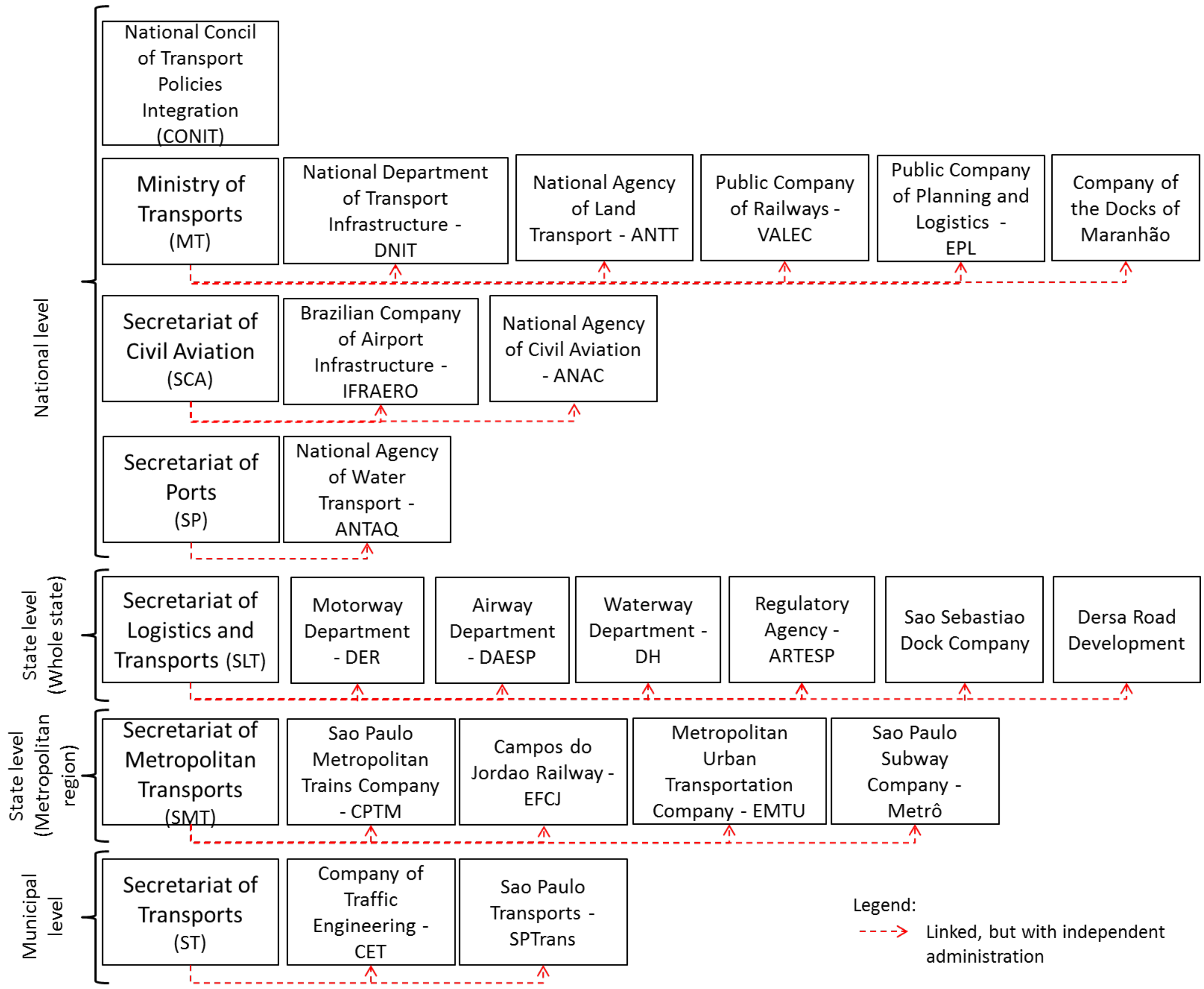

Figure 2 - Institutional organization of transport sector in national level (Brazil), state level (state of Sao Paulo and metropolitan region of Sao Paulo) and municipal level (city of Sao Paulo). Source: Adapted from Ministry of Transports (2015), Secretariat of Civil Aviation (2014), Secretariat of Port (2014), Secretariat of Logistics and Transports (no date), Secretariat of the Metropolitan Transports (no date) and Municipal Secretariat of Transports (2016).

The reports accessed were first characterized with regards to their legal nature (statutory and mandatory nature), inter-modality (unimodal or multimodal) and scope (transport services/infrastructure, urban mobility, climate change), based on Fischer (2002).

Subsequently, the content of the PPP reports was analysed following Krippendorff (2004), in order to identify how at each moment of the planning process environmental aspects were considered, and to identify what environmental issues were included. To accomplish these purposes, the many parts of the PPP reports were used as units of analysis (objectives, baseline information, assessment of effects, monitoring, decision, guidelines/recommendations), and data collected in each unit of analysis were coded according to the environmental aspects they refer to (Figure 2). These categories were defined based on the documents' content.

Table 3 – Policies and plans analysed.

Administrative level	Strategic level	Year	Initials	Name

National	Policy	2009	PNAC	National Policy of Civil Aviation
		2010	PNTH	Guidelines for the Nacional policy for water transport
		2012	PNMU	National policy of urban mobility (Law 12.587/2012)
	Plan	2007	PNLT	National Plan of Transport and Logistics
		2009	PNLT	National Plan of Transport and Logistics
		2012	PNLT	National Plan of Transport and Logistics
		2012	PNLP	National Plan of Port Logistics (Master Plans)
		2013	PNIH	National Plan for Waterway Integration
		2013	PHE	Waterway Strategic Plan
		2013	PSTM	Sectorial Plan of Transport and Urban Mobility for Climate Change Mitigation and Adaptation
State (Whole state)	Plan	2000	PDDT	Master Plan of Transport Development
		2010	PTS	Sustainable Transport Plan
		2013	PTS	Sustainable Transport Plan
State (Metropolitan region)	Plan	2006	PITU	Integrated Plan of urban transports
		2010	RRC	Regional Rail Connection: Preliminary Consideration and Guidelines
		2012	CDU	Urban Development Scenario
		2013	ARM	Update of the Metropolitan Network
Municipal	Policy	2014	PDE	Municipal Policy of Mobility (part of the Municipal Master Plan - Law 16.050/2014)
	Plan	2015	PlanMob	Plan of Urban Mobility

Results were presented in a quantitative way, showing how often (*frequency*) policies and plans mentioned each category by unit of analysis; in which unit of analysis environmental and social issues were most mentioned (based on the sum of frequencies of each category); and how comprehensive each policy and plan were, based on the number of categories they covered. Finally, the importance of those environmental and social issues in decision-making were also analysed based on the justifications presented by the reports.

3. Results

3.1 Environmental and social issues in legislation applied to transport planning

Results are presented of the consideration of environmental and social issues in the legal frameworks applied to transport planning at national, state and municipal levels. The first legal instrument that needs to be highlighted is the Federal Constitution, which includes an article dedicated specifically to the environment, stating that: "Everyone has the right to an ecologically balanced environment, which is a good of common use and essential to a healthy quality of life, being the Government and the community responsible to defend and preserve it for present and future generations" (Brazil, 1988, article 225). According to the Constitution the main purpose of defending and preserving the environment is to guarantee a good quality of human life (Machado, 2013). Environmental protection is also included as a principle of economic activities, (Brazil, 1998, article 170).

Figure 2 – Coding process: units of analysis and categories.

Units of analysis	**Categories**
Objectives	Sustainability
Baseline information	Environment (general)

Environmental issues

Social issues

Because the duty to protect and preserve the environment is shared between the Government and communities, both are in violation of the Constitution when they allow environmental aspects to be ignored or poorly represented. To protect and preserve the environment is a common duty of federal, state and municipal authorities (Brazil, 1998; Brazil, 2011), and the Government is understood as the manager – but not the owner – of environmental goods (Machado, 2013). The importance of governmental action in maintaining a healthy environmental balance is also reinforced in other legislations such as the National Policy of the Environment (Law 6,938/1981) (Ministério dos Transportes, 2002).

Generally speaking, environmental and social issues are mostly related to transport projects and actions (e.g. legislation about environmental licence of projects, environmental impact assessment of projects, environmental and social criteria for public agreements, control and monitoring of vehicular emissions, vehicles adaptation for disabled people). Statements for transport planning are less frequent, and can be divided into five groups (Table 2):

- general guidelines for public planning: these may indicate that public policies, plans and programmes should aim at sustainable development, rational use of environmental resources, environmental protection, pollution control, increase quality of life and the consideration of environmental and social criteria in decision making;

- guidelines for transport planning: these may revolve around investment in sustainable transport; diversification of transport modes; priority to pedestrians, non-motorized transport and collective transport; they also include specific guidelines for urban mobility plans;

- climate change policies: these might refer to guidelines for sustainable transport; the necessity to reconcile transport policies with Climate Change Policy; the establishment of targets and actions to reduce greenhouse gas emissions; actions to mitigate and monitor emissions; actions to improve land use and reduce trip length; support collective transport and less pollutant modes; incorporate 'climate change dimension' into decision making process;

- mobility and accessibility policies: these might establish the principle of universal accessibility, the right of transport and mobility for disabled people; elimination of mobility obstacles;

- planning instruments: these might refer to transport plans that are mandatory and need to include environmental and social issues according to the law: Sectoral Plan of Transport and Urban Mobility for Climate Change Mitigation and Adaptation (stablished the National Policy of Climate Change), Plan of Urban Mobility (defined by the National Policy of Urban Mobility), Control

Plan of Air Pollution by Vehicles in Use and Programme of Monitoring and Maintenance (both stablished by CONAMA Resolution 18/1995);

- impact assessment instrument: these might refer to Strategic Environmental Assessment, presented as an instrument to assess environmental effects of public and private planning, considering climate change.

The identified environmental and social issues applied to transport planning at national, state and municipal levels were mostly included as principles or guidelines to transport planning, making the constitutional principle of sustainability explicit (Machado, 2013). Mechanisms and instruments to implement principles and guidelines are defined by the legislation. They are less frequent, though.

The exceptions here are planning and impact assessment instruments. These are mechanisms to implement objectives and principles defined by legislation. However, planning instruments (Plan of vehicular air pollution, Climate Change Plans applied to transport and Urban Mobility Plan) have a limited scope regarding environmental and social issues, comprehending mainly only mobility/accessibility issues and pollutant emissions and climate change issues. Moreover, the mentioned impact assessment instrument was not regulated yet, hindering its practice.

3.2 Environmental and social issues in transport institutions

Table 3 summarises results of the institutional analysis, indicating what institutions: have a formal environmental/social policy, include environmental and social issues in their purposes or underlying values, mention environmental and social issues as sectorial instructions and actions, and the focus of those guidelines and actions.

Only three out of 27 institutions (11%) did not mention anything about environmental and social issues. Among the institutions that did mentioned some information, nine (33%) have a formal environmental and/or social policy, 11 (41%) have environmental and/or social concerns embedded in their purposes or values, 12 (44%) draw on environmental and/or social instructions, and 21 (78%) report some kind of action related to environmental and/or social issues.

Related to institutional purposes and values, terms connected to sustainable development include: ‘sustainable development’ (3), ‘sustainability’ (1), ‘social and environmental development’ (1), ‘sustainable solutions’ (1)) and to institutional responsibilities (‘social and environmental responsibility’ (3), social responsibility’ (2)). Other terms mentioned are: ‘environmental quality’ (1), ‘respecting the environment’ (1), ‘conformity with the environment’ (1), ‘social justice’ (1), ‘improving quality of life’ (1) and ‘social participation’ (1).

Based on the qualitative analysis of the information collected it was observed that instructions and actions identified can be distinguished into six groups, based on their main focus: i. institutional management (e.g. implementation of Institutional Environmental Management System); ii. planning (e.g. inclusion of environmental aspects in planning and decision making); iii. projects (e.g. use of Environmental Impact Assessment and Environmental Licence to projects); iv. educational activities (e.g. production of educational material about accessibility and cycling); v. general instructions (e.g. promote environmental quality and energy efficiency); vi. others actions (e.g. rules for transporting dangerous loads).

Table 4 – Environmental and social issues identified at each administrative level, presenting some of the corresponding legal instruments

Environmental and social issues	National	State	Municipal
General guidelines for public planning	National Policy of Environment (Law 6,938/1981); National Policy of Water	State Policy of Environment (Law 9,509/1997); Strategy for the Sustainable	Municipal Programmes of environmental Quality (Decree

	Resources (Law 9,433/1997)	Development of the State (Decree 58,107/2012)	42,318/2002); Social and Environmental criteria for the development and implementation of public policies, programmes and actions (Law 15,572/2012)
General guidelines for transport planning	National Policy of Urban Mobility (Law 12,578/2012)	State Policy of Climate Change (Law 13,798/2009); Strategy for the Sustainable Development of the State (Decree 58,107/2012)	Indicator of public services quality (Decree 47,972/2006); Municipal Policy of Climate Change (Law 14,933/2009)
Climate change/pollutant emissions	National Policy of Climate Change (Law 12,187/2009)	State Policy of Climate Change (Law 13,798/2009)	Municipal Policy of Climate Change (Law 14,933/2009)
Mobility and accessibility	Statute of the disabled people (Law 13,146/2015)		
Planning instruments	Control Plan of vehicular air pollution (CONAMA Resolution 18/1995); National Policy of Climate Change (Law 12,187/2009); National Policy of Urban Mobility (Law 12,578/2012)		
Impact assessment instrument		State Policy of Climate Change (Law 13,798/2009)	Municipal Policy of Climate Change (Law 14,933/2009)

Instructions and actions are mostly related to projects, and only six institutions (out of the 27) clearly mentioned some concern regarding considering environmental and social issues in planning: three at national level, two at state level, and one at municipal level (Table 3). Thus, it is possible to notice that environmental and social issues are spread in transport institutions; however, they are mostly related to the project level.

3.3 Environmental and social issues in transport planning practice

Analysed policies and plans are presented in Figure 3, as well as their characteristics regarding the administrative level they refer to, strategic level, legal nature, inter-modality, scope and the institution responsible for each PPP.

Table 3 – Institutional characteristics regarding: existence of a formal environmental and social policy, environmental and social issues in institutional purposes and values, environmental and social instructions, actions straight related to environmental or social issues and classification of each institution regarding the focus of their instructions and actions (Institutional management, Planning, Project, Educational activities, General instructions and Other actions). Legend: ■ Mentioned; -- Not mentioned; I – Institutional management; Pl – Planning; Pr – Project; E – educational activities; G – General instructions; O – Other actions.

Institutions		Formal Policy	Purposes or values	Guidelines	Actions	Focus of guidelines and actions					
						I	Pl	Pr	E	G	O
National	CONIT	--	■	--	--	--	--	--	--	--	--
	MT	■	--	■	--	■	■	■	--	■	--
	DNIT	--	■	■	■	--	--	■	■	--	--
	ANTT	--	■	--	■	--	--	--	■	--	--
	VALEC	■	--	■	■	■	--	■	■	■	--
	EPL	--	--	■	■	■	■	■	--	--	--
	Docks of Maranhao	--	--	--	--	--	--	--	--	--	--
	SCA	--	--	--	--	--	--	--	--	--	--
	Infraero	■	■	■	■	■	--	■	--	■	--
	ANAC	--	--	--	■	--	--	--	■	--	--
	SP	--	■	■	■	--	--	■	--	■	--
	ANTAQ	■	■	■	■	--	■		--	■	■
State (whole state)	SLT	■	■	■	■	--	■	--	--	■	--
	DER	■	--	■	■	■	--	■	--	■	--
	DAESP	■	--	■	■	--	--	■	--	■	--
	DH	--	--	--	■	--	--	■	--	■	--
	ARTESP	--	■	--	■	--	--	--	■	■	--
	Dock of Sao Sebastiao	--	■	--	■	--	--	■	--	■	--
	Dersa	--	■	--	■	--	--	■	--	■	--
State (metropolitan region)	SMT	--	--	--	■	--	--	--	■	■	--
	CPTM	■	■	■	■	■	--	■	--	--	--
	EFCJ	--	--	--	--	--	--	--	--	--	--
	EMTU	--	--	--	■	--	--	■	--	--	■
	Metro	■	--	■	■	--	■	■	--	■	--
Municipal	ST	--	--	--	--	--	--	--	--	--	--
	CET	--	--	--	■	--	--	--	■	--	■
	SPTrans	--	--	--	■	--	■	■		--	■
% of total		33	41	44	78	22	22	59	26	52	15

From the 19 cases analysed, six were mandatory. Three (PSTM, PTS 2010 and PTS 2013) were required by Climate Change legislation, and another three (PNMU, PDE and PlanMob) were related to urban mobility and required by national legislations. These three cases of urban mobility are statutory. The National Policy of Urban Mobility (PNMU) and Municipal Policy of Mobility (PDE) were published as legislations and the Municipal Plan of Urban Mobility (PlanMob) was published as a Municipal Decree.

Another defining feature is the predominance of PPs that include more than one mode (12 out of 19 cases). Despite the fact that some authors are critical that investments in transport infrastructure remain concentrated on road transport (Costa, 2012), the existence of multimodal policies and plans may indicate a shift in diversifying the transport network, as indicated by Medeiros (2014) about the National Plans of Logistics and Transport (PNLT 2007).

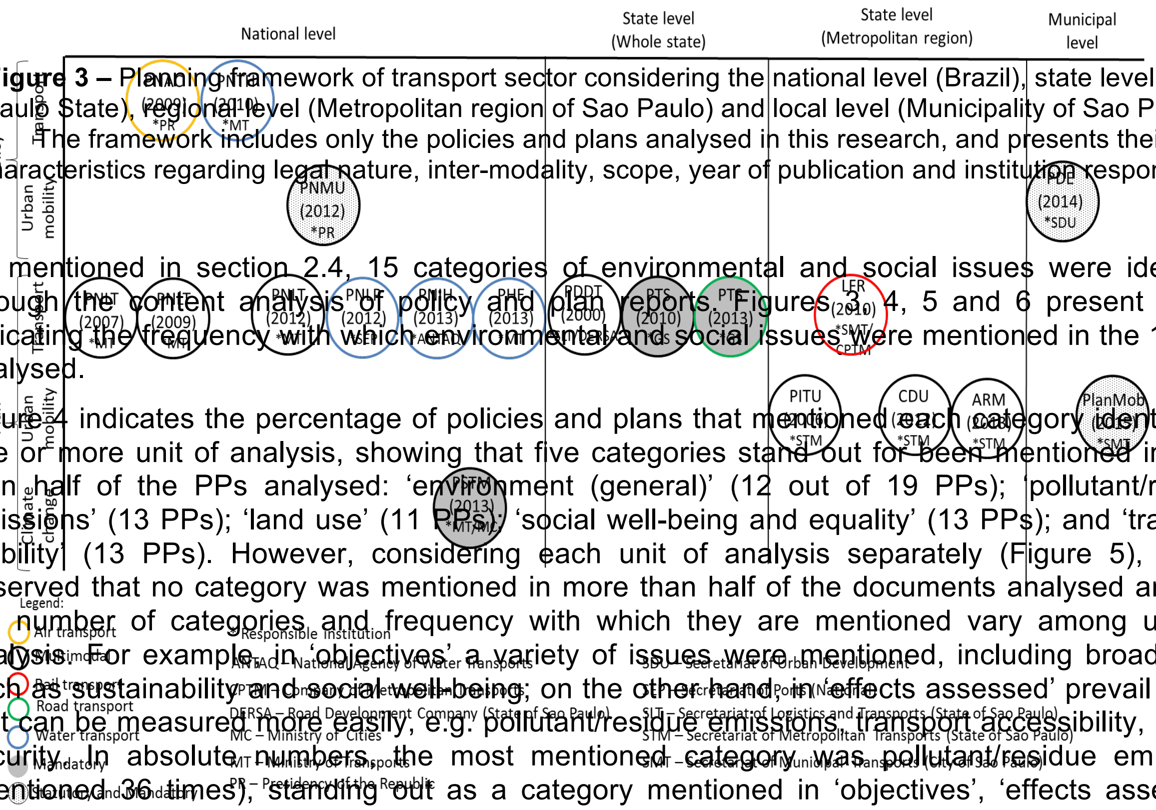

Figure 3 – Planning framework of transport sector considering the national level (Brazil), state level (Sao Paulo State), regional level (Metropolitan region of Sao Paulo) and local level (Municipality of Sao Paulo). The framework includes only the policies and plans analysed in this research, and presents their characteristics regarding legal nature, inter-modality, scope, year of publication and institution responsible.

As mentioned in section 2.4, 15 categories of environmental and social issues were identified through the content analysis of policy and plan reports. Figures 3, 4, 5 and 6 present results indicating the frequency with which environmental and social issues were mentioned in the 19 PPs analysed.

Figure 4 indicates the percentage of policies and plans that mentioned each category identified in one or more unit of analysis, showing that five categories stand out for been mentioned in more than half of the PPs analysed: 'environment (general)' (12 out of 19 PPs); 'pollutant/residue emissions' (13 PPs); 'land use' (11 PPs); 'social well-being and equality' (13 PPs); and 'transport mobility' (13 PPs). However, considering each unit of analysis separately (Figure 5), it was observed that no category was mentioned in more than half of the documents analysed and that the number of categories and frequency with which they are mentioned vary among units of analysis. For example, in 'objectives' a variety of issues were mentioned, including broad ones, such as 'sustainability' and 'social well-being'; on the other hand, in 'effects assessed' prevail issues that can be measured more easily, e.g. pollutant/residue emissions, transport accessibility, human security. In absolute numbers, the most mentioned category was pollutant/residue emissions (mentioned 36 times), standing out as a category mentioned in 'objectives', 'effects assessed', 'decision criteria' and 'guidelines'.

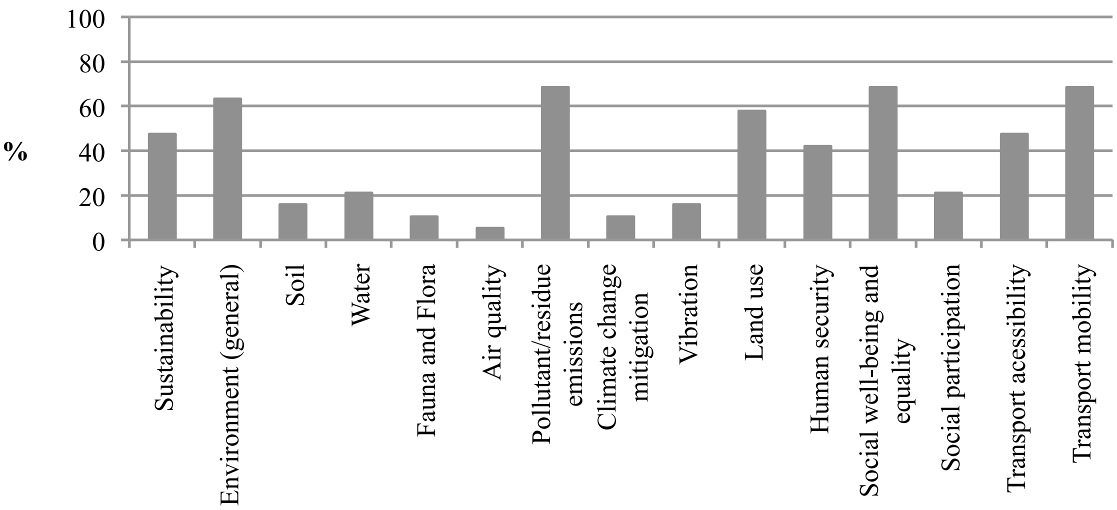

Figure 4 – Percentage of policies and plans (frequency - %) that mentioned each category in one or more units of analysis.

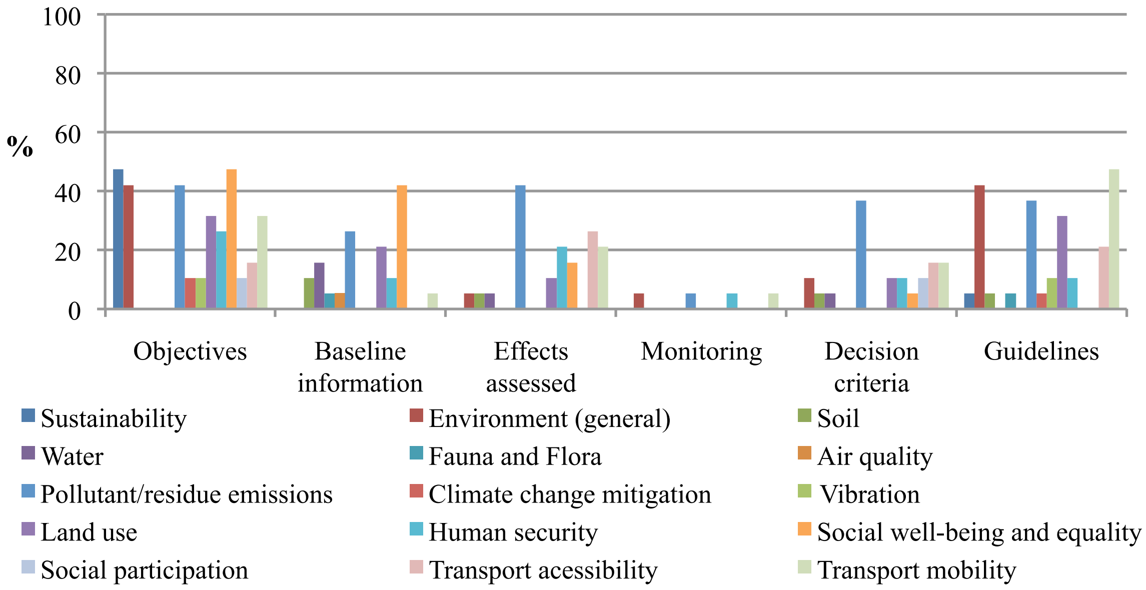

Figure 5 – Frequency (%) with which environmental and social issues were mentioned in policies and plans analysed, presented by unit of analysis (objectives, baseline information, effects assessed, monitoring, decision criteria and guidelines).

These results indicate that, in general, the theme environment and society is recurrent in the transport policies and plans analysed. However, they are not consistently considered along the whole planning (Figures 6 and 7), but most frequently mentioned in 'objectives', and 'guidelines', and less frequent in 'monitoring'. Thus, it shows that in some PPs environmental and social issues were well considered in the level of intentions (as an objective to be followed or as a guideline for future PPPs and actions); nevertheless, not all of them were explicitly considered along assessment and decision phases (Figure 7).

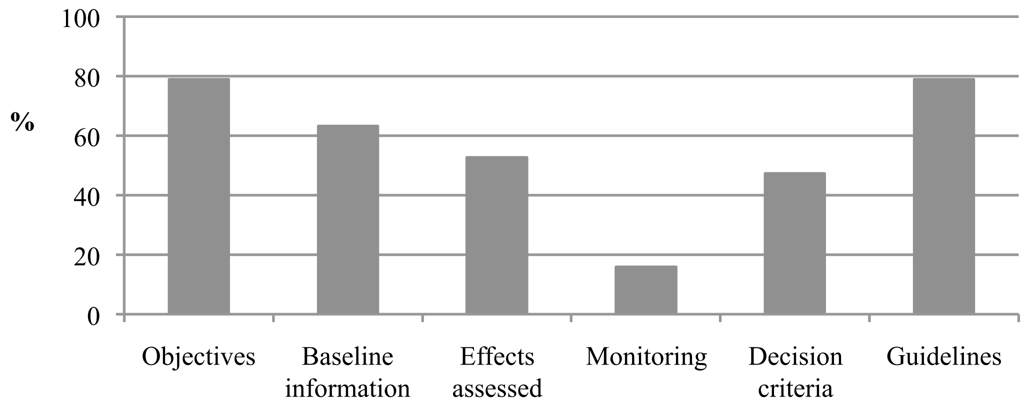

Figure 6 – Percentage of policies and plans (frequency - %) that mentioned one or more environmental or social issue by unit of analysis.

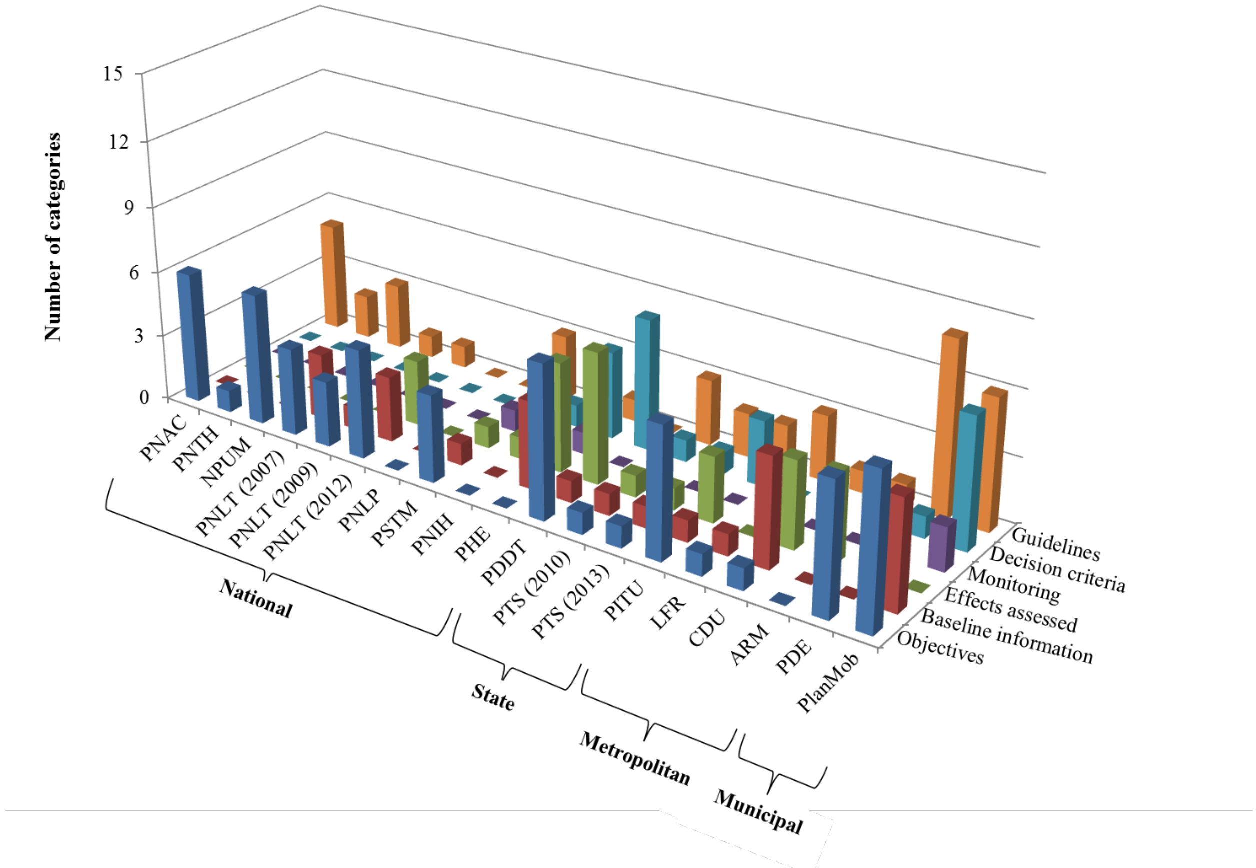

Figure 7 – Number of categories (environmental and social) mentioned in each PPP by unit of analysis (objectives, baseline information, effects assessed, monitoring, decision criteria and guidelines).

Specifically with regards to the units of analysis ('decision criteria'), among the plans that mentioned environmental or social issues in decision (see Figure 7), in two cases (PSTM and PDE) this referred to social participation, as those plans promoted public consultation; two others (PTS 2010 and PTS 2013) explicitly considered only gas emissions; one (PNIH) considered land use as a criteria to decide locations for water transport infrastructure; and four plans and PlanMob) were more comprehensive, including a group of categories.

In three of those cases (PHE, PDDT and PITU) the selection of the preferred option was based on a multi criteria analysis, including environmental and social criteria. Whilst considering a more comprehensive group of environmental and social issues can be interpreted as positive, it is important that the method used assume that trade-offs between environmental, social and economic issues are accepted. Moreover, in the cases of PHE and PDDT, it was assumed that environmental and social issues are less important than economic issues, as they received a lower weight, thus, influencing decisions to a lesser extent.

It is also worth mentioning the National Policy of Logistics and Transports (2012), in which it was reported that the decision was based only on the economic return of the projects because it would be "too complex to develop a model that considered other criteria in addition to the economics" (Ministério dos Transportes, 2012, p. 195). This illustrated the general low importance that environmental and social issues have in transport planning.

Finally, it is important to acknowledge that this analysis is limited to the content of the documents assessed. Thus, any information omitted in those documents are not analysed here. It is especially relevant in the cases of the National Policy of Urban Mobility (PNMU) and the Municipal Policy of Mobility (PDE), which are published as laws (not reports) that do not present information regarding baseline, effects assessment, and decision criteria.

4. Discussion

This study indicates that in the transport sector, environmental and social issues are, to the same extent, mentioned in the contextual aspects analysed: legal, institutional and practical.

Within the legal framework, the necessity to respect and protect the environment and human well-being is well stablished by the Federal Constitution and reinforced by other legislation. In particular with regards to the incorporation of environmental and social issues in transport planning, there is legislation stressing this, especially as part of the underlying principles and guidelines. On the other hand, instruments and mechanisms to support and assure this incorporation at planning levels is scarce, as most of the rules are specific for transport projects and actions, but not to upper/strategic levels of decision.

With this regard, it is important to mention that this characteristic is not specific of the transport sector, but is related to the way some environmental instruments were regulated in Brazil, namely the environmental impact assessment, which is bound by the environmental licence of projects (Leuzinger and Cureau, 2008). Moreover, management instruments in the country have been traditionally based on a 'command and control' approach (based on legal requirements and mechanisms to assure their compliance), dealing with each activity in an isolated way (Andrade et al., 2001).

Within the institutional context, environmental and social concerns are presented by some institutions as part of their purposes/values and policies, and reported as instructions and actions. However, most of the instructions and actions identified are related to projects, and only few of them relate to planning. There is a strong relationship between legal and institutional contexts in the sense that institutional actions are concentrated on what is required by law (projects), and little regards is given to planning.

In relation to the practical context of transport planning, the analysis of transport policies and plans shows that the consideration of environmental and social issues is poor and mainly focused on pollutant emissions and mobility/accessibility issues. It is important to mention that climate change/pollutant emissions and mobility and accessibility are issues specifically addressed by laws applied to transport planning.

This result reinforces the importance legal requirements play in the Brazilian context when it stablishes mechanisms and targets and, at the same time, reinforces the gap in incorporating the issues presented by legislations and institutions only as principles and guidelines into planning practice. Thus, understanding decision making as a way "to connect a level of values and a level of facts" (Fürst and Scholles, 2001 cited by Stoeglehner, 2010, p 220), we can say that in transport sector strategic decision making is failing in incorporating environmental and social issues in the level of facts, except when there is a legal instrument that forces it.

Similar observations were made by Fernandes (1992), who questioned the efficiency of environmental legislation in Brazil, affirming that environmental problems in the country were not of a legal, technical or financial nature, but political, which "relates to the economic interests of dominant groups existing in Brazilian society, challenges all the country's juridical-institutional apparatuses and, finally, reveals the wild character of Brazilian capitalism" (Fernandes, 1992, p. 43). As a consequence, the environment was not truly recognized as a value in the decision process, but mentioned as a rhetorical argument (Fernandes, 1992). More than a decade later, this paper indicates that, in transport sector, there is still an important lack of effective recognition of the environment in planning and decision making processes.

Shortcomings in including environmental and social issues in decision making and, as a consequence, in promoting sustainability has been observed internationally and in a variety of sectors and geographical scales (May, 2015; McManners, 2016; Montabon et al., 2016; Schuetze and Chelleri, 2015; UN, 2015; UNDP, 2014) and, as mentioned by Sánchez and Croal (2012, p. 51), mainstreaming sustainability into policy making is "the biggest challenge of all". Aiming at improving this scenario, "transformational solutions to the sustainability challenge" have been claimed (McManners, 2016, p. 91) and different mechanisms has been used worldwide, including developing guidelines and legal requirements (May, 2015; Sowman and Brown, 2006), implementing participatory processes (Sowman and Brown, 2006; Stuart et al., 2016), to implementing impact assessment instruments such as Strategic Environmental Assessment and Sustainability Assessment (Gibson, 2006; Hacking and Guthrie, 2006; Fischer 1999a; b).

In the Brazilian case the few mechanisms identified to support the consideration of environmental and social issues in transport planning have a narrow scope or are not implemented yet. Considering that and the actual development scenario of Brazil, were there is strong pressure to accelerate economic development (e.g. through the National Growth Acceleration Programme and Programme of Investments in Logistics) and a clear competition between environmental/social interests and economic interests in the policy arena (Marques and Peres, 2014), the tendency is to maintain (or worsen) the actual practice of not considering environmental and social issues adequately within planning processes

In this case, environmental and social issues would continue to be considered only in the context of individual projects, maintaining the situation were many conflicts (including the ones related to upper level decisions) arise late in the process (Fearnside, 2006; Gallardo and Bond, 2011; Sánchez and Silva-Sánchez, 2008). It is worth mentioning that also at the level of projects there are economic and political pressures to accelerate economic development without adequately incorporating environmental and social issues in Brazil, what can be observed through recent changes and proposals to change legislations, e.g. new legal instruments to facilitate the fast-tracking of infrastructure projects (Marques and Peres, 2014), alteration in resolutions and law proposal regarding Environmental license and Environmental Impact Assessment of projects (Bill 3,729/04 and 654/15), Constitutional Amendment Proposal (Proposal 215), the new Mining Code (Bill 5,807/2013).

In the context of a clear predominance of economic interests over environmental and social ones, the incorporation of environmental and social issues in the level principles and guidelines is not enough to entrench these issues within sectorial planning and guarantee its consideration in decision making.

5. Conclusions

In order to develop a better understanding of the extent to which environmental and social issues have been considered in transport planning in Brazil, the sector was analysed regarding the integration of these issues into legal, institutional and practical contexts.

The analysis shows that there are environmental and social principles stablished within legal and institutional contexts that might apply to transport planning. Those principles, tough, are rarely transposed to mechanisms, instruments or actions related to planning. Within practice, the policies and plans analysed show that environmental and social issues are poorly considered, usually focused on pollutant emissions, mobility and accessibility issues, and are more frequently mentioned as a guideline for future plans and actions, or as a policy/plan objective, which are not pursued along the policy/plan. Some of the plans stand out for considering a more comprehensive group of environmental and social issues, however, in some of them these issues were as less important when compared to economic interests, and trade-offs between them where admitted.

These results indicate that environmental and social issues were generally included in the level of intentions, but usually were not adequately considered through planning practice and decision making. Moreover, it points to a relationship between planning practice and legal context, as obligations regarding the issues most considered in practice (pollutant emissions/climate change issues, mobility and accessibility) are clearly mentioned in legal instruments. Thus, considering that to entrench environmental and social issues within planning is necessary to achieve the "strategy of sustainable development" (Healey and Shaw, 1993, p. 773), transport planning in Brazil still have a long run to go.

Intending to understand better what factors hinder the implementation of environmental and social principles and values that are already stablished in legal framework and included as a value by some institutions, we point to the necessity to study the planning process in transport sector in

Brazil, which might point to opportunities to improve the environmental and social quality of transport planning.

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Framework for SEA enhancement in small islands

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Abstract

Territories with specific features, such as small islands, may need "tailor made" SEA approaches in order to effectively have resilient plans and programs. There is a lack of research on the subject as well as on the key factors to be introduced in the assessments of small islands. Previous work identified that these territories mainly use the same regulations, guidance and procedures as the ones used in the mainland. Also, it was identified the need for a specific SEA approach considering key-issues such as regional cooperation networks, and guidelines taking into account the environmental and cultural small islands specificities. But there is still a need to understand how key-issues may effectively be introduced in the SEA system of small islands. The research goal was to develop a framework to help different stakeholders identify and characterize key-issues to implement good SEA practices in small island context. The framework developed provides the identification of the main components of the SEA process, analysing the key-players, roles and relationships and the whole institutional framework. Furthermore, it helps stakeholders, namely, public authorities, consultants, developers and decision-makers to develop appropriate criteria and establish the underlying principles upon which islands decision-makers and SEA technicians should base the assessment.

Keywords: conceptual framework; context; small islands; strategic environmental assessment; sustainability

How strategic is the Strategic Environmental Assessment of future Portuguese marine spatial plans in the European context?

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Abstract

In the European context set by Directive 2001/42/EC and its transposition into national legal frameworks, (Strategic) Environmental Assessment (SEA) is mandatory for plans and programmes likely to have significant environmental effects. Portugal's national maritime space (NMS) includes c. 50% of marine waters of the European Union and covers 4% of the Atlantic (c.1% of the global Ocean), making it one of the world's largest maritime nations. Since 2014, new Portuguese legislation has been published pertaining to marine spatial planning and management (MSPM) creating a system that comprehends two levels of instruments: strategic instruments (the National Ocean Strategy, NOS2013-2020); and operational instruments (MSPlans), including the Situation Plan for the entire NMS, which will represent and identify "the spatial and temporal distribution of existing and potential uses and activities" as well as "natural and cultural values of strategic relevance for environmental sustainability and intergenerational solidarity". Although this Situation Plan is more akin to a "reference situation" than to a "Plan", the significance of its potential and expected environmental effects led the Portuguese government to decide subjecting it to SEA. Still, in the current Portuguese MSPM system, prospective and strategy are found at the level of the NOS2013-2020 that adopted the 2012 European Commission's "Blue Growth" vision for the maritime sector, which, in turn, constitutes "the maritime dimension" of EUROPE 2020, the 2010 EU strategy for "smart, sustainable and inclusive growth". This hierarchy of instruments, from the European to the Portuguese national level, sequentially guided and framed strategic options for each lower ranking level. In this context, two questions emerge: Were any of these levels in the policy/planning hierarchy subjected to environmental assessment? and, How "strategic" can SEA of a future Situation Plan actually be? A revision of the types of assessments carried out for these instruments showed that no other plans, programs or strategies, along the hierarchy where the Situation Plan is included were subjected to environmental assessment (the POEM, a study for a MSPlan developed between 2008 and 2010, was subjected to SEA but it only applies to c. 8.5% of the NMS, and was carried under different socio-economic and legal/political conditions). Environmental assessment of the proposed Situation Plan, the key operational instrument of the Portuguese MSPM system, is a necessary step towards ensuring the proposed national sustainable development objective. We propose it should follow a strategy-based approach in view of the nature, scope and relevance of the issues at stake. Besides incorporating MSPM principles, SEA of the Situation Plan should encompass other key aspects for the success of MSPM of the Portuguese Atlantic Ocean: build on long-term scenarios accommodating the duration of planned licences (25 y) and concessions (50 y); take global change as a major factor for strategic scenarios development, together with societal, demographic and economic drifts, all covering similar time spans. Scale and value of Portuguese NMS implies that success or failure of its MSPM process will have significant impacts on MSPM of European Maritime Space, making this process a European and global milestone.

Keywords: MSP, SEA, Situation Plan, Portugal

1. Introduction

1.1. The Strategic Environmental Assessment perspective

Strategic Environmental Assessment (SEA), as set forth by EU Directive 2001/42/EC on the assessment of the effects of certain plans and programmes on the environment (OJEU, 2001), stems from the evaluation of transboundary environmental impacts, in the framework set by the UN Convention on Environmental Impact Assessment in a Transboudary Context, adopted in Espoo in 1991 and amended in 2001 (UN, 2015). This accounts for a widely spread practice where SEA is viewed as an impact assessment-based approach, differing from a traditional Environmental Impact Assessment in that its object is a policy, plan or programme (PPP) instead of a project (Fischer, 2007; Noble and Nwanekezie, 2016).

A different conceptualization of SEA as a strategy-based approach capable of influencing the development and application of PPPs and as such, as a process for influencing the decision-making process and driving institutional change, constitutes the opposite end of the gradient from less to more strategic approaches SEA can assume (Noble and Nwanekezie, 2016).

As van Doren et al. (2013) suggest, the impact of SEA on decision-making will be more significant if it is explicitly used as a tool to develop policy, as opposed to merely being used to review predefined proposals, when SEA still has value but its contribution to the planning process is strongly reduced and opportunities are lost for relevant decision-making processes where social, economic, and environmental interests are at stake.

Within this conceptual framework, SEA can and should become instrumental in influencing the political decision-making process towards a better environmental performance, thus assuming a major advocacy role for effective sustainability (Partidário, 2015).

1.2. The Portuguese National Maritime Space and its spatial planning and management system

Portugal is one of the world’s largest maritime nations. Its national maritime space (NMS) comprises 1,700,000 km^2 of ocean area that includes territorial seas and exclusive economic zones of the mainland, and of the archipelagos of Madeira and the Azores (Bessa Pacheco, 2013). This amounts to 41% of the maritime space of the European Union, and an estimated 48% of the total volume of its marine waters, under Portuguese sovereignty or jurisdiction (Governo de Portugal, 2014). With an additional 2,100,000 km^2 of proposed extended continental shelf, Portugal’s total NMS encompasses c. 3,800,000 km^2, roughly 4% of the Atlantic Ocean’s area and c. 1% of the global Ocean (Bessa Pacheco, 2013).

Therefore, Portugal’s approach to its ocean management will arguably be relevant all the way from national to European and global levels.

Since 2014, a new Portuguese legal framework has been published which defines Marine Spatial Planning and Management (MSPM) of the Portuguese NMS:

- in February 2014, the National Ocean Strategy 2013-2020 (NOS 2013-2020) and its associated action plan (Plan Mar-Portugal) was published (Diário da República, 2014a), replacing its forerunner, the NOS 2006-2016;

- in April 2014, the National Law establishing the Basis of the Policy for Marine Spatial Planning and Management of the National Maritime Space (MSPM Law), whose ultimate aim is to contribute “to the country’s sustainable development” (Diário da República, 2014b, p. 2358); and

- in March 2015, a Decree-Law (Decree-Law 38/2015) developing important aspects of the implementation of the MSPM Law and transposing the EU’s Marine Spatial Planning (MSP) Directive (Diário da República, 2015a).

The national MSPM system thus created comprehends different levels of policy instruments, ranging from strategic, namely the National Ocean Strategy 2013-2020, to operational, the MSPlans. According to both the MSPM Law and its corresponding Decree-Law, these operational MSP instruments include a Situation Plan for the entire national maritime space, and a number of allocation plans, one for every additional/new use or activity in the NMS (Diário da República, 2015a).

The Situation Plan will cover the entire NMS and include “The identification and spatial and temporal distribution of existing and potential uses and activities” (Diário da República, 2015a, p. 1527), namely aquaculture, marine biotechnology, marine mineral resources, energy resources and renewable energies, scientific research, recreation, sports and tourism, underwater cultural heritage and, equipments and infrastructures. It will also identify “natural and cultural values of strategic relevance for environmental sustainability and intergenerational solidarity” (ibid), including Marine Protected Areas (MPAs) and special conservation and protection areas classified within national and European frameworks, e.g. EU’s Natura 2000 network. This plan will also include “identification of networks, infrastructures and systems needed for national defence and security and for civil protection” (ibid.).

The Situation Plan can be phased according to the three maritime zones identified in the MSPM law: territorial seas, EEZs, and the extended continental shelf.

Allocation plans correspond to new uses or activities not identified in the Situation Plan and upon approval they immediately integrate the Situation Plan promoting its corresponding automatic amendment.

1.3. SEA in the Portuguese MSPM system

In view of its potential and expected significant effects on the environment, the Situation Plan directly falls under the scope of EU’s 2001/42/EC Directive on Strategic Environmental Assessment that aims “to provide for a high level of protection of the environment and to contribute to the integration of environmental considerations into the preparation and adoption of plans and programmes with a view to promoting sustainable development” by ensuring that “(…) an environmental assessment is carried out of certain plans and programmes which are likely to have significant effects on the environment” (SEA Directive, 2001/42/EC, p. L 197/32).

This view was adopted in the 11494/2015 Dispatch from the Portuguese Minister of Agriculture and the Sea that defined that “The situation plan is subject to environmental assessment under Decree-law 232/2007” (Diário da República, 2015b, p. 29495), the diploma that transposed the above mentioned EU Directive 2001/42/EC into the Portuguese legal framework.

As defined in Decree-law 38/2015, the Situation Plan is more akin to a “reference situation” than to an effective plan (in fact, its own designation suggests as much), in that it is viewed as a set of “written and graphical elements” that identify and zone present and prospective uses and activities in the Portuguese NMS, impending territorial plans and programs, environmental and use values and restrictions, and that locate elements pertaining to navigation, artificial islands, installations and structures.

In fact, within the current Portuguese MSPM system, prospective and strategy are to be found at the level of the National Ocean Strategy (NOS) 2013-2020. The NOS is based “on a new paradigm for sustained development, guided by the vision of the European Commission for the maritime sector: ‘Blue Growth’” (Diário da República, 2014a, p. 1317). The Blue Growth strategy (European Commission, 2012), in turn, constitutes “the maritime dimension” of EUROPE 2020, the 2010 EU strategy for “smart, sustainable and inclusive growth” (European Commission, 2010). In practice, this hierarchy of instruments, from the European to the Portuguese national level, sequentially guided and framed strategic options at each lower ranking level, effectively narrowing the range of available strategic options.

In this context, two questions emerge: Were any of these levels in the policy/planning hierarchy subjected to a Strategic Environmental Assessment, so as to evaluate to what level sustainable development is actually being promoted? And, how “strategic” can a Strategic Environmental Assessment of the future Situation Plan actually be? The following sections present tentative answers to these questions.

2. Methods

SEA can be viewed as the construction and comparative evaluation of alternative strategic development visions and perspectives, integrating biophysical, economic, social and political considerations (Dusik and Xie, 2009). This type of environmental assessment applies to the highest level in the planning and decision process, hence its strategic character. Where PPPs are part of a hierarchy, the SEA framework advocates avoiding duplication of assessments. As Therivel (2014) points out "… because of tiering, SEA has the potential to promote more streamlined decision-making, where decisions taken at one planning stage (using SEA at that stage) may not need to be revisited at subsequent stages of decision-making (and their SEA or EIA)" (p.17).

The hierarchy of instruments that are the core of this analysis is synthesized in Figure 1, ranking from the key European policy instruments that define Europe's strategic options, down to the Portuguese legal framework for MSP, and is proposed operational instruments.

To answer the questions presented above, an analysis was carried out of the types of evaluations they were subjected to and on the appropriateness of SEA at every level. It is followed by a discussion of the range of possibilities available for an SEA of the situation plan.

Figure 1. Hierarchy of European and national Portuguese instruments framing Portugal's MSP.

3. Results and discussion

3.1. Were any of these levels in the policy/planning hierarchy subjected to an SEA, so as to ensure that sustainable development is actually being promoted?

In its transitory dispositions, Decree-Law 38/2015 stipulates that until the adoption of the Situation Plan, the Portuguese Maritime Spatial Plan (POEM) is to be taken as the reference situation for MSP of the NMS and for the allocation of all private use titles. The POEM was the first attempt at MSP in Portugal, having been developed between 2008 and 2010 only for the EEZ of the Portuguese mainland (Frazão Santos et al., 2014). Still, it was never published or recognized as an effective plan and was later, in 2012, published online as a study (Calado and Bentz, 2013; Frazão Santos et al., 2014). Although the POEM was subjected to SEA (MAOT, 20120), it must be stressed that this cannot be translated into the present situation plan due to three main reasons: i) the POEM covered only about 8.5% of the territory encompassed by the situation plan; ii) it was developed more than 6 years ago, in a very different context, both in socio-economic and legal terms; and iii) the corresponding SEA process was also never duly closed, namely lacking the respective public consultation phase.

Although the Situation Plan will include "*strategic*, legal, technical and scientific bases of its indications and determinations" (emphasis added), the MSPM law clearly states that the strategic level of MSPM in Portugal is the NOS2013-2020 (Diário da República, 2015a).

The NOS 2013-2020 and its associated action plan (Plan Mar-Portugal) underwent a public consultation process prior to publication (DGPM, 2013) but, unlike other Portuguese national strategies, as, e.g., the Portuguese National Integrated Coastal Zone Management strategy, which had a voluntary SEA process (Partidário, 2009), it was not subjected to SEA. The ensuing legislation establishing the MSPM Law was only subject to discussion in the Portuguese parliament (Becker-Weinberg, 2015; Frazão Santos et al., 2015).

As mentioned above, the NOS 2013-2020 adopted the sustained development model of the 2012 European Commission's "Blue Growth" strategy, the maritime arm of EUROPE 2020. Both initiatives chart the EU's strategic course/route until 2020, and, consequently, that of its member states. The three themes of EUROPE 2020 (smart growth, sustainable growth and inclusive growth) were subjected to a public consultation carried out by the Commission (European Commission, 2015). For the Blue Growth communication, a study was conducted focusing on "Scenarios and drivers for sustainable growth from the Oceans, seas, and coasts" (Ecorys et al., 2012).

Because they are neither plans nor programmes, the SEA Directive does not apply, *sensu strictu*, directly to either strategy and they were published without an environmental assessment even though the SEA Protocol to the 1991 UN/ECE Espoo Convention, mentioned above and adopted by the EU in 2008 (OJEU, 2008), targets policies and legislation and endeavours "to ensure that environmental, including health, concerns are considered and integrated, to the extent appropriate, in the preparation of proposals for policies and legislation" (ibid., p. L 308/33). Also, according to Wood and Djeddour (1991, in Therivel, 2004, p. 12) "a policy… may be considered as the inspiration and guidance for action" and can be included in the bundle of "strategic actions".

Both at the European and Portuguese national levels, implementation of these strategies and corresponding visions is likely - and expected - to have significant environmental effects, but none was subjected to some kind of environmental assessment, meaning that no holistic, prospective and long-term assessment has been carried to ascertain the course they define as a significant contribution to the overarching aim of fostering and promoting sustainable development.

3.2. How "strategic" can the Strategic Environmental Assessment of the future Situation Plan actually be?

Besides being bound by the successive upper levels in the hierarchy that the Portuguese MSPM system integrates and the corresponding strategic and political options, according to Decree-law 38/2015, the Situation Plan is more akin to a "reference situation" than to an effective plan (cf. section 3.1., above). In this context, where the Blue Growth policy option has already been decided on, there appears to be little latitude for a strategic-based SEA of the future Situation Plan to develop and compare alternative strategic scenarios. The fact that certain development options may be considered promising in general terms, does not preclude the necessity of a detailed analysis to ascertain their adequateness to a particular context. The Blue Growth strategy is "an initiative to harness the untapped *potential* of Europe's oceans, seas and coasts for jobs and growth" (European Commission, 2012, p. 2, emphasis added). SEA of marine spatial planning, particularly because marine spatial plans are expected to have significant environmental effects, is the framework for identifying and evaluating the fulfilment of that potential (OJEU, 2014).

Moreover, aspects arise from the legal framework of the Situation Plan that constitute windows of opportunity for such an approach:

i. How to best ensure an appropriate organization and use of Portugal's NMS in view of its valorisation and safeguard, with the ultimate objective of the country's sustainable development?

ii. How to meet the principles of Portuguese MSP, namely the ecosystem approach, adaptive and integrated management, long-term valuation and promotion of economic activities, and regional and transboundary cooperation and coordination?

iii. While both EUROPE 2020 and the NOS 2013-2020 and its associated Plan Mar-Portugal target the 2020 horizon, licences to be granted for the Portuguese NMS by the MSPM system will be valid for up to 25 years and concessions for up to 50 years, taking us up to 2041 or up to 2066 (at least). How can operational MSP adapt and integrate such distinct objectives as the stability and security investors require and adaptation/reaction to change, including natural and anthropogenic?

Due to the nature, scope and relevance of the issues at stake, we believe that a Strategic Environmental Assessment along the process that led to the present Portuguese MSPM system must follow a strategy-based approach. In fact, as Lobos and Partidário (2014) identified, such an environmental assessment encompasses complex decision arenas; instead of product-oriented, it will have to be process-oriented; institutional and governmental capacities to support the underlying policy and planning process must be developed and strengthened and; constructive and collaborative dialogue is an absolute need for the process to be successful.

4. Conclusions

Despite defining national sustainable development as its ultimate aim (MSPM law), the Portuguese MSPM system and its strategic framework, from EUROPE 2020 to the NOS 2013-2020, did not undergo any environmental assessment approach.

The EU Sustainable Development Strategy includes the objective to "safeguard the earth's capacity to support life in all its diversity, respect the limits of the planet's natural resources and ensure a high level of protection and improvement of the quality of the environment" (Commission of the European Communities, 2005), while the precautionary principle under the Lisbon Treaty requires Environmental Sustainability as the foundation for the EU's commitment to sustainable development (Qiu and Jones, 2013). Thus, irrelevant of assuming a hard or a soft sustainability concept (ibid.), an environmental assessment of the proposed Situation Plan, the key operational instrument of the Portuguese MSPM system, represents a necessary step towards ensuring the proposed national sustainable development objective.

We propose a strategy-based SEA that accompanies, integrates and informs the development of the Situation Plan through collaborative dialog as the most suitable and beneficial approach to contribute to development of this plan and its underlying policy options, as opposed to an impact assessment-based approach merely reviewing a (more or less) predefined proposal, namely based on the existing POEM.

Rather than being a mere *pro forma* in the Situation Plan development process, solely to meet legal requirements, this approach can both promote identification of opportunities and contribute to better informed risk evaluations for potential future uses of the Portuguese NMS.

Besides incorporating the MSPM principles, including an ecosystem approach, adaptive and integrated management, long-term valuation and promotion of economic activities and, regional and transboundary cooperation and coordination, this SEA should encompass a group of key aspects for the success of MSPM of the Portuguese share of c. 4% of the Atlantic ocean:

1) SEA of the Situation Plan must build on long-term scenarios accommodating the duration of planned licences and concessions. Portuguese NMS and the European Atlantic will be widely different in 25 to 50 years;

2) Global change must thus be taken as a major factor for strategic scenarios development;

3) Societal, demographic and economic drifts and corresponding scenarios must also cover similar time spans.

We believe that the extension, scale, and value of the Portuguese NMS implies that success or failure of the Portuguese MSPM process will have significant impacts in the overall European Maritime Space and its spatial planning and management, making this process an European and global milestone.

Acknowledgements

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A decision support framework for the sustainability assessment of environmental goods

Haley Knudson, Dina Aspen, John Eilif Hermansen

Abstract

This study presents the development and application of a comprehensive decision support framework to identify and appraise potential environmental goods (EGs) for the WTO Environmental Goods Agreement (EGA) negotiations. The purpose of the EGA is to reduce tariffs on an identified list of environmental goods and technologies in order to promote international sustainable production, consumption and development through liberalized trade. Currently, 17 WTO member-states are working on developing and agreeing on such a list. Determining what does or does not qualify as an EG is a dynamic process in which the design, production, resource use, end-of-life, societal context, stakeholders and need versus desire for the good must be considered. A systematic approach to EG identification is therefore necessary in order to identify relevant goods and validate their contribution to the overall goals of such global sustainable development agreements. This methodology was developed across a study, commissioned by the Norwegian Ministry of Foreign Affairs, to investigate and produce a list of EGs for potential nomination to the EGA. Particular focus was placed on goods that help meet basic needs in developing countries in an environmentally-friendly way, such as solar lamps and cookers. Principles from systems engineering, industrial ecology and value-focused thinking are integrated to synthesize a holistic approach to the identification and appraisal of EGs that is both transparent and legitimate. The EGA negotiations take place in a complex decision-making environment where representatives must consider the interests of multiple stakeholders, while also ensuring coherence with a wide range of regional, national and international regulatory frameworks and rules. *Systems thinking* principles are used to structure the decision context so that policy makers are equipped with a methodology to balance these interests. *Industrial ecology* provides the perspective necessary to fully evaluate potential products and impacts from a holistic perspective. Finally, *value focused thinking* helps determine important criteria, metrics and decision-making rules for selection and validation of goods. Combined, this integrated framework provides a traceable, coherent and transparent approach to identify and validate EGs, ensuring efficient and credible decision-making procedures in a complex environment. The framework offers a general approach that may be applied to any trade agreement seeking to mitigate environmental impacts from production and consumption of goods.

Keywords: Environmental goods, Environmental Goods Agreement (EGA), systems thinking

‘Matching’ through Governance – Strategic Environmental Assessment and Sustainability

Margarida Monteiro, Maria Partidário

Abstract:

Strategic Environmental Assessment (SEA), as a political support instrument that adds value to strategic decisions over constructively consider sustainability, can facilitate decision-making, help understand the complexity of the decisions within environmental, sustainability, and institutional contexts, pointing out the relevancy of the exercise of power in strategic developments. But how can this be possible if, as generally acknowledged, current SEA practices are strongly linked to the assessment of effects, mostly from a technical perspective, and the production of a report to support licensing, approval or clearance of development instruments such as programmes, plans or policies? Our point is that this reactive approach is limiting the capacity of SEA to meet public policy sustainability aims. This void between what is being advocated and the real practice prompts the following question: how can SEA enhance the legitimacy of public policies in development contexts towards sustainability? This paper states that it is only possible to ‘match’ SEA with contexts of transitions for sustainability by adopting the lens of Governance. Understanding the territorial specificities, relational dynamics, expectations and priorities, or the institutional blockers and facilitators is crucial when working in strategic levels of decision. Legitimacy is seen as a validity of institutional order resulting throughout the development process, where knowledge-share is a pre-requisite as well as transparency and actors capabilities and resources; Sustainability as an adaptive and reflexive objective; and Governance as a relational concept that provides legitimacy to the exercise of power. Supported by a literature review, and with some empirical illustrations, we conclude that to promote sustainable paths of development and institutionalize sustainability, any SEA approach needs to be built upon principles of transparency, adaptability, reflexivity, complexity, justice, and strategic-thinking. We also highlight that explicitly analyzing and assessing the power dynamics in strategic developments towards sustainability can secure SEA as a promising instrument in the prosecution of sustainable governance. This requires a change of practice which does not go without difficulties that any change entails, but we believe can be overcome by expression of benefits of dealing with uncertainty in long-term perspectives, managing different expectations, admitting power as a transformative capacity, or even the distinguishing between legitimacy by ruling or by success.

Keywords (*up to five*): SEA; governance; sustainability; legitimacy

Track: Track A. Adaptive sustainability policies and models in changing contexts

Track B. Oceans and Marine Sustainability: Innovation and Management

Session 0B-08

Sustainability indicators of different components of Portuguese fisheries: changes needed towards sustainable fisheries

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Abstract

Fisheries have a huge impact on marine populations and ecosystems. More than 75% of fish stocks are overexploited and a wide diversity of other negative impacts has been attributed to fisheries. Nonetheless, fish consumption has been increasing worldwide, which strongly increases the concern on the assessment, management and conservation of fisheries resources, as well as of marine habitats. In this study, we have applied several sustainability indicators, integrating environmental, economic and social dimensions, to the main components (roughly corresponding to different métiers) of Portuguese fisheries. The analysis outlined marked differences between fisheries components, being the trawl fishery the one with the lowest values for the majority of the indicators considered. None of the fisheries components revealed a satisfactory sustainability. For each case, measures towards sustainability were proposed, as well as a monitoring plan with relevant indicators that can more effectively assess fisheries sustainability.

Performance evaluation for Portuguese Marine Spatial Planning

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Abstract

Ocean governance frameworks, including marine spatial planning (MSP), are generally aimed at achieving sustainable use of the marine environment and of its finite resources, and are increasingly being developed and implemented worldwide. Although the importance of evaluating the success of integrated ocean management initiatives is widely recognized, so is its complexity, and there is still limited knowledge or empirical experience on how to actually carry out such an evaluation. The main aim of this research is the development and testing of a framework to evaluate the performance of marine spatial plans (focusing on the outcomes). Portugal's maritime area totals c. 3,800,000 km^2, i.e., c. 4% of the Atlantic Ocean and 1% of the global Ocean. As one of the world's largest maritime nations, and with its ocean governance framework finalised in 2015, Portugal emerges as relevant case study. For the evaluation methodology showcased here, objectives of Portuguese marine spatial plans (MSPlans), as set out in national legislation published in March 2015, were matched to a preliminary list of indicators, selected from a literature review of scientific and technical references on the evaluation of policies and plans and expert interviews. Indicator selection was also supported by a review of ocean monitoring commitments assumed by Portugal, including the national monitoring related to the Marine Strategy Framework Directive, to identify and take advantage of potential areas of overlap, avoiding duplication of efforts, and minimizing implementation costs. The preliminary list of 65 performance indicators was fine-tuned through structured interviews with selected Portuguese and international experts, and resulted in a list of 37 indicators addressing many of the suggestions raised by the experts. The proposed approach contributes to evaluation of progress towards achieving sustainability objectives, the ultimate goal of MSP, and to highlight gaps, not only in terms of needed information, but also in terms of important concerns for MSP that current frameworks may not address. Despite the necessary adjustments related to the unique contexts of each individual case, the proposed framework may constitute a useful tool in the emerging field of MSP evaluation, supporting decision making and management processes, in articulation with the UN's Sustainable Development Goals (particularly Goal 14, for the Ocean).

Keywords: Marine spatial plans, performance evaluation, outcome evaluation, indicators, Sustainable Development Goals

1. Introduction

Marine spatial planning (MSP) has been defined as the "public process of analysing and allocating the spatial and temporal distribution of human activities in marine areas to achieve ecological, economic, and social objectives (…)" (Ehler and Douvere, 2009, p. 18). Though relatively recent as an approach, it is being increasingly endorsed and used worldwide as a tool to the integrated management of growing human demands on marine resources (UNESCO-IOC, 2015). In fact, according to Flannery et al. (2016), MSP "has rapidly become the most commonly endorsed management regime for sustainable development in the marine environment" (p. 121). Although the importance of evaluating the success of integrated ocean management initiatives, particularly

MSP, is widely recognized (UN, 2016), so is its complexity, and there is still limited knowledge or empirical experience on how to actually carry out such an evaluation (Carneiro, 2013). However, the ever-growing human pressures on the marine environment, and the pivotal role of the ocean in determining sustainable development and ultimate well-being of humankind, makes such evaluation essential.

Portugal has been selected as an appropriate and relevant case study for the development and testing of a mechanism to evaluate the performance (focusing on the outcomes) of its marine spatial planning system for three main reasons:

- It is one of the world's largest maritime nations: Portugal's maritime area totals c. 3,800,000 km^2, i.e., c. 4% of the Atlantic Ocean and 1% of the global Ocean (Bessa Pacheco, 2013). Portugal alone has sovereignty/jurisdiction over almost 50% of marine waters in the European Union (Governo de Portugal, 2014);
- Unique strategic position, bridging between Europe, Africa, and the Americas (Diário da República, 2014a), not only in geographic but also cultural terms (privileged relations with coastal Portuguese speaking nations in Africa and South America);
- Brand new legal framework for MSP (MSP system), including: the National Ocean Strategy 2013-2020, published in February 2014, stating Portugal's strategic objectives for its national maritime space (NMS) (Diário da República, 2014a); the MSPM Law establishing the Basis of the Policy for Marine Spatial Planning and Management of the NMS, published in April 2014, whose main goal is to contribute to the sustainable development of Portugal (Diário da República, 2014b); and Decree-Law 38/2015 detailing aspects of the implementation of the MSPM Law and transposing the EU's MSP Directive (2014/89/EU of 23 July) (Diário da República, 2015).

As pointed out by Carneiro (2013), "What to evaluate depends unavoidably on the timing of the evaluation" (p. 216). Portugal is presently developing the Marine Spatial Plan – the Situation Plan – for the entirety of its NMS. However, even though no plans exist as yet, and "while (…) many tangible results could take 5-15 years to be realized, it's not too early to think about evaluating the results of MSP" (Ehler, 2014, p. VI).

Performance evaluation, an assessment of progress toward the achievement of pre-defined goals or objectives in planning, should ideally be based on a reduced and manageable set of explicit standards – indicators, which should be directly linked to intended objectives (e.g., Day, 2008; Laurian et al., 2010; Douvere and Ehler, 2011). Indicators can be defined as "quantitative/qualitative statements or parameters that can describe existing situations and manage changes or trends over time" (ibid., p. 307).

The indicator selection process should involve stakeholders through a collaborative approach (Ramos, 2009). The literature offers several likely important criteria for indicator selection, which often vary according to the purpose and scope of the evaluation, such as relevance, feasibility, information availability, cost-effectiveness, context sensitivity, time and space comparability, robustness and scientific credibility, concreteness, interpretability, specificity, i.a. (Hammond et al., 1995; IOC, 2006; Johnson, 2008; Vilares, 2010). In practice, often only two or three such criteria are effectively used to rank indicators (e.g., Ramos et al., 2004; Coelho et al., 2010).

For the purposes of the research reported here, a step-by-step approach was designed to develop a set of indicators that could constitute the core of an evaluation mechanism of the performance of the Portuguese MSP system (Figure 1).

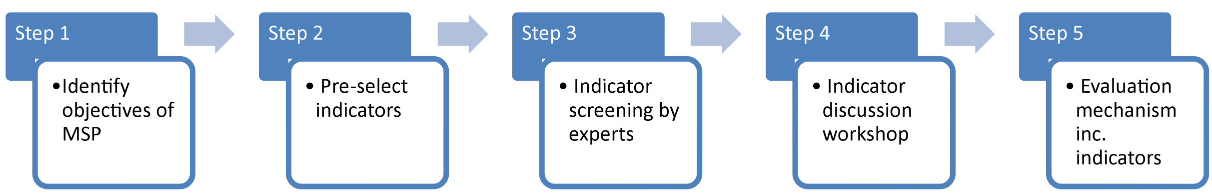

Figure 1. Step-by-step approach adopted to develop a set of indicators that could constitute the core of an evaluation mechanism of the performance of the Portuguese MSP system.

The first step involved the identification of the most appropriate source of objectives to assess performance of national MSP. From the three legal instruments available, namely, NOS 2013-2020, MSPM Law, and Decree-Law 38/2015, the latter, stating the objectives of (future) Marine Spatial Plans, emerged as the most appropriate level of analysis. In step 2, indicators were tentatively matched to these objectives, excluding objective a) for its strategic nature and vague phrasing, and for not being specifically related to MSP (Table 1). Such indicators were selected from a literature review of scientific and technical references on the evaluation of ocean governance initiatives, particularly MSP and MSPlans, including the implementation of international conventions and commitments, and European Directives pertinent to maritime issues and sustainable development. A review of ocean monitoring commitments assumed by Portugal was also carried out to take advantage of areas of overlap, to avoid duplication of efforts, and minimize costs, hoping to increase the likelihood of the implementation of such a monitoring and evaluation mechanism. In step 3, the 65 indicators were screened through one-on-one expert interviews. The ensuing analysis produced a new, reduced, set of indicators, to be debated in an expert workshop (step 4). The final stage, step 5, integrates the resulting set of indicators and proposes an evaluation mechanism for the Portuguese MSP system.

Table 1. Objectives of Portuguese Marine Spatial Plans, stated in Decree-Law 38/2015, followed, in parentheses, the number of indicators proposed for each objective. Objective a) was not included in this analysis due to its strategic character and lesser relevance to MSP.

a) To implement the objectives of strategic development established in the strategic instruments of the spatial planning and management of the national maritime space, namely in the National Ocean Strategy (0);
b) To promote the sustainable economic, rational and efficient exploitation of marine resources and ecosystem services, ensuring the preservation, protection and recovery of natural values and coastal and marine ecosystems and the good environmental status of the marine environment, as well as of coastal and transition waters, preventing the risks of human action and minimizing the effects of natural catastrophes and climate change (46);
c) To align (order) the uses and activities to be developed in the national maritime space taking into account the marine ecosystems and the safeguard of underwater cultural heritage, aiming to ensure the sustainable use of resources and fostering creation of employment (7)
d) To prevent or minimize eventual conflicts among uses and activities developed in the national maritime space (4);
e) To ensure legal certainty and transparency of the procedures entrusting the rights of private use in the national maritime space (6);
f) To ensure the use of available information on the national maritime space (2).

Steps 1 and 2 of this approach have already been presented in Ferreira et al. (2016). In this paper we present the methodology and the results of stage 3.

2. Methods

National and international interviewees were selected based on their expertise in the fields of MSP and/or planning evaluation. These included MSP practitioners, members of various branches of academia (biology, ecology, law, geography), experts on indicators, independent consultants, non-governmental organizations (NGOs) (Table 2).

Semi-structured interviews were conducted as per standard social science protocol (e.g., Bernard, 2006). The interviews were structured around the list of 65 indicators. Interviewees were asked to rank indicators in terms of relevance (direct link with policy objectives), and feasibility (operationalizing capacity) (Ramos et al., 2004). They were asked to rank both criteria using a scale of 1 (low relevance or feasibility) to 3 (high relevance or feasibility). No answer, or non-applicability were recorded as 0 (Coutinho, 2014).

The interviews included open-ended questions related to an overall evaluation of the methodology with the possibility to comment on proposed indicators and/or to propose additional indicators. It was assumed that the interviewees would guide the discussion towards topics of genuine concern.

Interviews took place in person or by telephone. All interviews were recorded (contingent on participants' permission) to enhance accuracy and completeness of the data record and later analysed for content.

In the analysis of results, the most important indicators should be the ones with a total score of six (sum of both criteria). Relevance was ranked as the main criterion, followed by feasibility.

3. Results and discussion

Twenty-four interviews were conducted between December 2015 and March 2016 (Table 2). Eighteen interviews yielded quantitative results for the indicators under scrutiny (Table 3). The remaining interviews (six of the international experts interviewed) produced qualitative information, focusing on suggestions to develop and simplify the set of indicators presented and offering suggestions for the introduction of other indicators.

Table 2. Categories and numbers of interviews.

National/international	Institution	No. interviews
National	National agencies (MSP)	4
	National accounting bureau (indicators)	1
	Academia (incl. Azores and Madeira)	9
	NGO	1
International	MSP Practitioners	2
	Academia (MSP experts)	3
	Independent Consultants/NGOs	3
	Accounting (EEA)	1

Interviewees commented on the large number of indicators proposed for objective b) and on the unbalance in the number of proposed indicators for each objective, but recognized it as a direct consequence of the difference in complexity of the various objectives (cf. Table 1). Figure 2 shows the results of the scoring of the indicators proposed for objective b): absolute values for each of the criteria are presented in the primary axis (maximum possible score of 54), and the total score (sum of relevance and feasibility) of the 46 indicators is presented in the secondary axis (for a maximum possible score of 108, achievable if the eighteen interviewees had given the maximum grade of three to both criteria for that indicator). Despite criticising the large number of indicators proposed, almost half of the participants found it difficult to effectively reduce the number of indicators, by attributing the highest score to ¾ or more of the 46 indicators proposed. Some participants acknowledged a difficulty in distinguishing between the individual importance of a given indicator in a general setting, and its strict relevance in this particular evaluation framework. I.e., although in general applications one indicator may be deemed important, it may be irrelevant for an evaluation of the current framework. In practice, this acknowledged difficulty may have contributed to raise the (overall) relevance scores of the indicators.

Based on these results, the twelve indicators with a score higher than 70 were retained, even if merged or renamed (Figure 2 and Table 3). The remaining indicators were, nevertheless, also analysed in terms of the comments received so as to be adapted, merged with others or discarded.

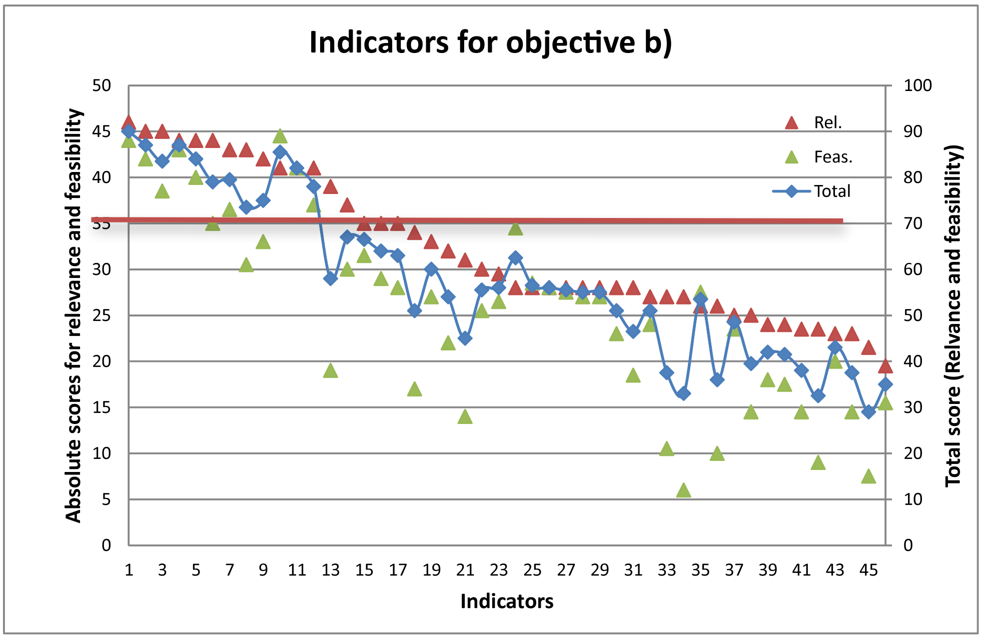

Figure 2. Indicators for objective b). Maximum possible score for each criterion was 54, and 108 for the sum of relevance and feasibility. Although the indicators are independent from each other, a connecting line was inserted in the total score series as a visual aid. The red line marks the threshold of the total score above which indicators were retained for further analysis.

The lower scores received by indicators relating to objectives e) and f) reflect some degree of dissatisfaction with the indicators proposed, for being too broad or general (Table 3). For all objectives a number of indicators were suggested by participants and integrated in the indicator set presented below (Table 4).

Interviewees generally suggested a reduction in the overall number of indicators – one participant suggesting only 4-5 indicators as a starting point – and that they should focus on measuring the direct results of the implementation of MSP, looking at the specificities of the process, so as to promote the concreteness and the interest of the evaluation. Also, an overall structure or framework should be sought to establish and clarify relations between indicators, rank and prioritise them, and avoid duplications or "double-counting".

The importance of focusing on trends, and of establishing a reference framework with known baseline conditions and predefined, time-bound targets, was stressed by various participants.

Table 3. Synthesis of results: For each objective of Decree Law 38/2015 (Obj.), proposed indicators are ranked by relevance (Rel.) and feasibility (Fea.). Total classifications (Tot.) refer to a possible maximum of 108 points (had an indicator received the maximum score from all 18 interviewees).

Obj.	Indicator (unit)	Rel.	Fea.	Tot.
b)	Coastal & marine area protected (%)	46	44	90
	Private investment in the national maritime space (€)	45	42	87
	GAV by sector of maritime economic activity (€)	45	39	84
	State of coastal and transition waters (WFD)	44	43	87
	Certified fisheries (%)	44	40	84
	Environmental Status of the marine environment (MSFD)	44	35	79
	Contribution of maritime economic activities in the trade balance (€)	43	37	80
	Changes in the use of maritime space (%)	43	31	74
	Public and private investment in RDT by sector of maritime activity (€)	42	33	75
	Requests to use the national maritime space (No.)	41	45	86
	Electricity generated from marine renewables (%, GWh)	41	41	82
	Certified aquaculture (%)	41	37	78
c)	Marine areas and coastline with formulated/adopted ICM/MSP plans (%)	51	44	95
	Employment rate in maritime sectors (%)	51	36	87
	Zoning plans and regulations completed, approved & implemented (%)	42	33	75
	Applications where there are potential impacts on a site designated for historical environment (No.)	39	38	77
	Monitoring & mapping of new historical environment sites discovered as part of a development (%)	39	27	66
	Condition of sites designated for historical environment (qual.)	39	19	58
	Employment rate of population aged 20-64 (%)	26	21	47
d)	Applications refused due to incompatibility with other marine uses (No.)	52	46	98
	Conflicts in the use of maritime space by type and frequency (No.)	48	27	75
	Applications where there are potential impacts on the marine environment as a result of infrastructure development (No.)	35	21	56
	Reported navigational accidents as a result of a marine development (construction or operation) (No.)	33	35	68
e)	Access to meeting documents (% requests)	32	17	49
	Access to data (% requests)	30	20	50
	Licenses refused (No.)	27	24	51

	Rules concerning the participation of civil society observers (Qual.)	24	13	37
	Conflicting processes at one-stop-shop (No.)	23	23	46
	Access to compliance and performance measures (No.)	23	8	31
f)	Existence of a system of annual update (Binary)	33	22	55
	Incorporation of knowledge into management plans (Quant.)	26	12	38

Participants also felt that it was too early in the planning stage to focus on plans which were not yet fully developed. Instead, they suggested shifting the focus to the Portuguese marine spatial planning system, currently composed by the NOS2013-2020, the MSPM law and Decree-Law 38/2015. Such refocusing would allow the immediate, more straightforward and more concrete development of indicators to monitor the implementation of specific aspects of the legal framework, and render the evaluation system more meaningful to users.

General concerns were also presented in terms of the temporal and spatial resolution of the indicators, including, for the latter, a careful consideration of the units in which the indicators are measured. These concerns stem from the sheer dimension of the Portuguese national maritime space, and the logistics behind maintaining regular data collection. Also, for such a vast space, figures presented as percentages may disguise or obliterate important quantitative changes.

There was no consensus on whether or not to include objective a): while some interviewees agreed that its phrasing was too broad to allow for the suggestion or identification of adequate indicators, others felt that it was necessary to include it in order to have a complete overview of objectives, and as the right place to include aspects left out in the other objectives.

Along these lines, some participants suggested that the focus of the analysis should be broader than, or not limited to, stated legal objectives, to allow the integration of other important aspects, such as: participation, coherence with other planning systems (namely the integration of terrestrial with marine planning), benefit sharing, cumulative effects, the precautionary principle, environmental impact assessment, strategic environmental assessment, quality of life, self-esteem, well-being. Despite the subjectivity, difficulty in establishing a direct link with MSP, and estimated low feasibility of the latter three, these aspects were deemed important by a number of participants as metrics of the outcomes of MSP and its contribution to sustainable development. In this respect, Strategic Environmental Assessment was mentioned by several participants as a hub to integrate all these concerns.

The integration of these results yielded the indicator set presented in Table 4. Each of the 37 indicators, briefly described in the text below, includes a code, the indicator name and measurement unit.

Monitoring being carried out in the framework of the European Marine Strategy Framework Directive (MSFD) and Water Framework Directive (WFD) will feed directly into indicators B1 and B2, which are, therefore, considered "placeholders" of the results of these assessments. Any changes perceived as negative may act as warning signs prompting the adoption of corrective measures in the framework of MSP. The WFD, although it applies to a minute fraction of the national maritime space, is particularly important as an indicator of pollution from land-based sources affecting the marine environment, and concomitantly, as an indicator of the land-sea interaction.

Requests to use the NMS and changes in its use (B3 and B4) are intended as metrics of potential and fulfilled interest in the use of such space, respectively. The latter includes the percentage of common use which reverts to private use, be it for private activities or for public uses, such as nature conservation, and defence. Both can be disaggregated in a number of more specific parameters.

The condition of Marine Protected Areas (MPAs) (B5), refers to the conservation status (e.g., good, reasonable, bad) of all types of MPAs (Natura 2000, OSPAR, nationally protected areas, etc.). It is hoped that this indicator can provide a measure of the effects of the management of the NMS in preserving natural values.

Table 4. Revised indicators for each objective of Decree Law 38/2015 (Obj.).

Obj.	Code) Indicator name (unit)
b)	*B1) Environmental status of the Marine Environment (Variable: MSFD)*
	B2) Status of coastal and transition waters (*Variable: WFD*)
	B3) Requests to use the national maritime space (No.)
	B4) Changes in the use of the national maritime space (Area or %)
	B5) Condition of Marine Protected Areas (MPAs) (*Qual.)*
	B6) Investment in the national maritime space (public and private) (€)
	B7) Contribution of the sea economy to the Gross Domestic Product (GDP) (%)
	B8) Gross Added Value (GAV) by sector of maritime activity (€)
	B9) Authorizations for research or pilot projects (No.)
	B10) Ecosystem services – Well-being: cultural/spiritual value of the sea (Qual.)
	B11) Activities with sustainability certification (No. or %)
	B12) Measures revoked or amended due to incompatibility with MSP instruments (No.)
	B13) Sand extraction areas in the NMS to combat coastal erosion (M m^3 or km^2)
c)	*C1) Area of the NMS with fully effective MSP (km^2 or %)*
	C2) Area of the NMS which is protected (%)
	C3) Activities/unit area (No.)
	C4) Processes of Environmental Impact Assessment (No.)
	C5) Condition of sites designated for their underwater cultural heritage (Qual.)
	C6) Employment in maritime sectors (No. or % of total employment)
	C7) Diversity of livelihoods related to the sea (No. or index)
d)	*D1) Conflicts in the use of the national maritime space by type and frequency (No.)*
	D2) Requests refused for being incompatible with other activities (No.)
	D3) Relocation of existing uses or activities (No.)
	D4) Renunciation to the rights of use (No.)
	D5) Titles changed/altered by degradation of the environmental status (No.)
e)	*E1) Titles decided by a public bidding process (No. or %)*
	E2) Titles not granted to original applicant (No.)
	E3) Revenue and use of taxes by type (€)

E4) (Public and private) costs of relocation or compensation (€)

E5) Information requests (No. and %)

E6) Fulfilment of procedural deadlines (No. or %)

E7) User satisfaction (Qualitative)

E8) Complaints (No. and %)

f) *F1) Existence of a geoportal on the national MSP system (Binary: Y/N)*

F2) Geoportal updates (No. or rate)

F3) Existence of mechanisms of information sharing (Binary: Y/N)

F4) Measures incorporated in plans as a result of new information (No.)

Private and public investment in the NMS, including public investment in MSP (B6), can provide a measure of intended or actual economic interest in this space. A related indicator is the contribution of the sea economy to the Gross Domestic Product (GDP) (B7). Although the value of GDP as an indicator is being increasingly criticized, particularly because it "overlooks the contribution of natural assets to wealth, health, and well-being" (OECD, 2011, p. 10), it relates directly to one of the strategic objectives of the NOS 2013-2020 (to promote an increase of the contribution of the sea economy to the GDP by about 50% until 2020). The Gross Added Value (GAV) by sector of maritime activity (B8) is intended to provide a better understanding of the individual contribution of existing and emerging activities to the sea economy.

The number of authorizations granted for research or pilot projects (B9) (eventually coupled with the number or fraction of such projects materialized in investment) is a measure of the interest in scientific research and technological development in the NMS.

Indicator B10 aims to provide a measure (even if subjective/qualitative) of the importance of the sea in people's lives and livelihoods (including non-consumptive uses, such as leisure) and how MSP affects it, positively or negatively. It is therefore intended as a metric of how MSP relates to well-being in terms of cultural/spiritual value of the sea, and a proxy for the evaluation of this type of ecosystem services. The number or percentage of economic activities with sustainability certification (B11), as it implies conformity with applicable regulations and patterns, is also proposed as an indicator of environmental sustainability.

Indicators B12 (Measures in territorial plans or programmes revoked or amended due to incompatibility or non-compliance with MSP instruments) and B13 (sand extraction areas in the NMS to combat coastal erosion), together with indicator B2, discussed above, are proposed as metrics for an evaluation of how the land-sea interaction is tackled at the governance and planning level. Indicator B13 is also intended as a measure of efforts to minimizing effects of natural catastrophes and climate change, the last aspect mentioned in objective b (cf. Table 1).

For objective c), related to the spatial planning of uses and activities, the area of the NMS with fully effective (i.e., elaborated, approved and implemented) MSP (C1), is proposed as a metric to evaluate progress of regional and national planning. Indicator C2, the area of the NMS which is protected, is related to international targets and obligations, namely the Aichi target and the United Nations Sustainable Development Goal of achieving a minimum of 10% of coastal and marine areas conserved by 2020 (UNEP, 2010; UNGA, 2015). Indicator C3 (Activities/unit area) is proposed as a measure of the coexistence of uses and efficiency in the use of the NMS.

The number of Environmental Impact Assessment for projects carried out in the NMS (C4) is proposed as a proxy of potential impacts on the marine environment generated by the activities under evaluation.

The condition of sites designated for their underwater cultural heritage (C5) is intended as a qualitative measure of the effects of the management of the NMS on the conservation status of such sites.

Employment in maritime sectors (C6) offers insight into economic and social aspects of MSP. It should provide information not only on jobs created, but also on jobs lost (thus integrating a consideration of the effects of new uses over existing ones), and on the average qualification of workers. The diversity of livelihoods related to the sea (C7) is a related indicator but with a different focus, centred on assessing the diversity of opportunities to sustain present and future generations. It is envisioned as a measure of local social resilience, akin to the diversity indexes so often used in ecology.

For objective d), five indicators are proposed. The number of conflicts in the use of the NMS by type and frequency (D1), is a measure of real conflict between: common uses, common and private uses, and private uses (sporadic, frequent, permanent). The number of private title requests refused for being incompatible with other activities (D2) is proposed as a measure of conflict prevention. The relocation of existing uses or activities (D3), including a discrimination of uses relocated on grounds of public interest, is envisioned as a measure of conflict minimization in the use of the NMS. A related indicator (D4) is the number of renunciations to private use titles as a result of the relocation of a use or activity. Also, the number of titles changed/altered by a degradation of the environmental status (D5) intends to show if/how the degradation of the environmental status (under the MSFD and/or the WFD) affects the activities taking place in the NMS.

For objective e), the number (or %) of titles decided by a public bidding process (E1), and the number of titles not granted to the original applicant (E2) are proposed as measures of legal certainty and transparency of legal procedures, including publicity, and participation.

Indicator E3 monitors the correct application of the taxes over marine activities, i.e., assesses if and how such taxes are being used as intended to ensure ocean monitoring, conservation, and surveillance. Indicator E4 (public and private costs of relocation or compensation), monitors the cost of relocating activities and who pays such relocation (whether it is public or private).

Indicators E5 to E8 offer metrics of public participation and access to procedural information (E5), predictability (E6), and user satisfaction related to the processes, namely their length and cost (E7), and conflict (E8).

Lastly, objective f), related to ensuring the use of the available information on the NMS, was found by participants as one of the most important objectives but also one of the most challenging. The limited number of indicators proposed reflects this difficulty. Most participants considered the existence of a single geoportal on the NMS (F1), one which is accessible and updatable by the various relevant institutions, to be crucial. This indicator is also related to the objective of transparency. The number or rate of geoportal updates (F2) contributes to evaluate the quantity of new information being used. The existence of mechanisms of information sharing (F3), particularly among national agencies relevant to MSP, was also deemed crucial, particularly by participants from agencies. Finally, the number of measures incorporated in plans as a result of new information (F4) is proposed as a measure of the actual use of available information.

In this step of the methodology we were able to reduce the number of indicators to approximately half, while broadening the range of topics covered, addressing many of the suggestions raised by the experts in terms of the incorporation of such topics as participation, coherence with terrestrial planning, environmental impact assessment, benefit sharing and well-being – critical elements in the determination of the sustainability of adopted options. The resulting set of indicators was discussed and further refined at an international workshop, the results of which are still under review, and will provide the basis for the development of a comprehensive evaluation framework of the MSP and management of the Portuguese sea, and of its contribution, as intended, to the sustainable development of Portugal and Europe’s seas.

4. Conclusions

Given the pivotal role of the ocean in determining sustainable development and ultimate well-being of humankind, evaluating the success of integrated ocean management initiatives, particularly MSP as the framework managing the ever-growing human pressures on the marine environment, is essential. However, there is still limited knowledge or empirical experience on how to actually carry out such an evaluation.

Portugal is a relevant case study for the development and testing of a mechanism to evaluate the performance of its marine spatial planning system. The set of indicators presented in this paper, integrating the views and suggestions of twenty-four international experts on the subject, constitutes one of five steps in the development of a comprehensive evaluation framework of the MSPM of the Portuguese NMS and of its contribution to the sustainable development of Portugal and Europe's seas.

The proposed approach thus contributes to evaluation of progress towards achieving sustainability objectives, the ultimate goal of MSP, and to highlight gaps, not only in terms of needed information, but also in terms of important concerns for MSP that current frameworks may not address. Despite the necessary adjustments related to the unique contexts of each individual case, the resulting framework may constitute a useful tool in the emerging field of MSP evaluation, supporting decision making and management processes, in articulation with the UN's Sustainable Development Goals (particularly Goal 14, for the Ocean).

Acknowledgments

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Oil Pollution in the North Sea: An example of the effective management of a marine environmental problem

Angela Carpenter

Abstract

Oil pollution entering the marine environment has been an issue of concern for many decades. Oil pollution can come from riverine outputs, land-based sources, accidental and intentional discharges from ships, and as a by-product of offshore oil extraction, for example. As a region, the North Sea saw high levels of oil pollution over many decades, with evidence of pollution dating back to 1915, for example, in Netherlands waters. As a result of growing awareness of the issue of oil pollution and its impacts on the marine environment in the late 1960s, measures were put in place to attempt to reduce or eliminate pollution from shipping and the offshore oil industry in the region. A framework for the environmental protection of the North Sea has developed extensively over many decades. This includes a range of governance measures such as international agreements, regional cooperation, EU and national measures. Estimated volumes of oil entering the North Sea from all sources vary widely - total inputs to the North Sea were estimated, in 1993, as being anywhere between 86,000 and 210,000 tonnes per year input to the marine environment while globally, the estimated average inputs of oil from ships and other sea-based activities for the period 1988-1997 was 1,245,200 tonnes per year. This paper examines the development of measures put in place since the late 1960s to protect the marine environment of the North Sea from pollution from ships, airborne and land-based sources. It considers a number of measures adopted since the end of the 1960s to reduce oil inputs in the region and presents data from the mid-1980s onwards on trends in pollution from ships; from the early 2000s for trends in pollution from oil installations. It presents data from a range of sources including in-situ monitoring for oil installations, and aerial surveillance and satellite monitoring for ship-source pollution. It also presents the findings of the 10-yearly Oslo and Paris Commission (OSPAR) Quality Status Reports. All these studies have identified significant reductions in oil pollution in the region over more than two decades, although there remain some areas where further action is needed to reduce oil inputs still further, especially from ageing oil and gas platforms. This paper illustrates that international cooperation between a number of countries and in different forms can result in a reduction in marine pollution leading to a cleaner environment. It also illustrates that new satellite surveillance technology offers a tool for environmental monitoring and increases the potential to identify the source of a pollution incident, raising the possibility of polluters being prosecuted for their actions.

Keywords: oil pollution; North Sea; marine environment; environmental governance; environmental monitoring

Sustainability Issues in the European Seaport Sector: Development of more sustainable and societally integrated ports

Angela Carpenter

Abstract

During the 1990s and 2000s the industry body representing Europe's sea ports – the European Sea Ports Organisation (ESPO) - identified a number of environmental issues facing the industry. These included water and air quality, noise pollution, energy consumption, port development (on land and water) and the disposal of waste from ships and from dredging as being issues of key significance. In 2003 ESPO developed an Environmental Code of Practice for its member ports to provide guidance and support in dealing with those environmental issues. Additionally, since 2009 with the introduction of the ESPO Award on Societal Integration of Ports, there has been a move towards the development of innovative ways to promote cooperation between ports and the cities in which they are located. In 2010 ESPO published its Code of Practice on Societal Integration of Ports, focusing on the human factor in ports – employees, people living in and around the port and the general public. In 2012, ESPO published a Green Guide "Towards excellence in port environmental management and sustainability" which brought together both environmental and sustainability issues. Through the use of environmental performance indicators, environmental management systems and a common vision of the European port sector on environmental sustainability, it can be argued that the European ports sector has generally improved its performance and ports have become more integrated within their local communities in recent years. The aim of this research is to identify how widely those improvements have occurred for different types and sizes of ports, and in different regions/countries around Europe. A review of applications by ports for the societal awards between 2009 and 2015 is being undertaken, together with good practice examples identified in Annex I of the ESPO Green Guide, in line with a 5Es approach to sustainability. That approach considers: exemplifying, setting a good example when managing own operations; enabling, providing conditions that facilitate users and enhance improved performance; encouraging, providing incentives to greener port users; engaging, with users and/or authorities in sharing knowledge and skills; and enforcing, setting rules and ensuring compliance. The paper will also examine the initial findings of a review of sustainability reports for approximately 40 European ports which considers the environmental aspects of ports, with particular reference to current arrangements for environmental management, and also looks at port sustainability efforts based on the guidance elements of the Green Guide. Those elements include air quality management initiatives, and energy conservation and climate change, for example, each examined in line with the ESPO 5E approach. The initial findings of that review will be developed which will contribute to the development of a survey to be disseminated to ports across Europe. From the documentary analysis so far, however, it can be concluded that ports have, since the late 2000s, become more sustainable and socially integrated and there are many examples of sustainability best practice that can be applied across the ports industry in Europe and also more broadly.

Keywords: European Union; Seaports; sustainability, environment; societal integration

Track C. Sustainability Knowledge Sharing: From Individuals to Countries

Session 0C-04

Debating the urban data revolution: risks, merits and implications for the new assemblages of city governance

Sara Moreno Pires, Liam Magee, Meg Holden

Abstract

Cloud-based computing, urban sensors, social network 'likes', 'digital footprints', open source software, real-time dashboards and crowd-sourced data are all the symbolic registers of an emergent new era of Big Data. An urban data revolution – with a growing role for civil society organizations and business in information and communication technologies – has announced itself at this historical juncture, promoting increasingly open, comparable and interactive web-based data, freely available with few restrictions, and signalling an ever more competitive, privatized and commoditized shift in our understanding of urban development success. This paper details the nature of the urban data revolution, which has emerged to international prominence in the last years. We discuss a number of prominent new data products and standards within this revolution, along with the critiques raised against it from urban and regional studies. While it's promise that big and fast data will improve cities has been heard before, there is little evidence that this new urban data revolution has learned from the practice of its predecessor, the community and sustainability indicators movement. Launched by world fora such as the Rio Earth Summit, what might be termed the penultimate urban data revolution can also be thought of as introducing new assemblages of actors and information products into the realm of urban governance. However important differences distinguish the two: notably, the new urban data revolution privileges the virtues of standardization and speed whereas the community indicators movement saw more value in locally-driven and long projects toward the global goal of sustainable development. There is both promise and risk within the new urban data revolution, but consequences of favoring fast-thinking over slow-thinking has serious implications for the governance assemblage that these efforts will be fit to produce and the consequences for sustainable development of cities. Therefore, our aim is firstly to engage with recent critical appraisals of the new urban data revolution, and to consider how these appraisals can connect with the work of the community indicators movement. Secondly, we consider the prospects for the urban data revolution in terms of their hardest-learned disappointments, particularly in relation to goals of open and participatory democratic cities in order to revalue the power of social learning in the construction of improved data options. Based on bibliography review, we reconsider five principles of best practice based upon the Bellagio STAMP and discuss implications for current urban data practice in terms of its key field of impact: the realm of urban governance. Conclusions reinforce that if new urban indicators are going to benefit cities in their democratic sense, they need good data institutions: public, resilient against political change, oriented toward learning by doing, and open to the diverse interpretations and uses of multiple users. Attention to institutional dimensions appears to stand in stark contrast to attention to innovation, from which basis the urban data revolution currently garners a great deal of enthusiasm. We close with a set of questions that serve both as an agenda for further urban research and for incorporation within emerging urban data governance practices.

Keywords: big data, sustainability indicators, community indicators, standardization, urban governance

Using Diagnostic Analytics to Find Best-in-Class Sustainable Corporate Water Management Practices

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Abstract

Modern enterprises worldwide seek to achieve efficient economic growth while also building sustainable, low-impact systems. Due to conflicts that arise when seeking these goals simultaneously, institutions must find innovative and effective solutions. We suggest in this work that institutions must not only evaluate themselves based on traditional, internally focused criteria, but also compare themselves to best-in-class examples of peer institutions utilizing similar resources. In order to do so, we present a diagnostic analytics based framework for action, which treats quantitative diagnostic analytics using super efficiency and two-stage data envelopment analyses (DEA) and qualitative diagnostic analytics using formal concept analysis (FCA). We focus this work on providing a practical example of this concept by studying sustainable water management in various institutions in the consumer staples sector. Central to this formal inquiry is the data and written documents obtained from the *2014 Water Carbon Disclosure Project (CDP).* Some of results of the study, as well as reflections, are reported here. First, we note the long-term goals of sustainable development of each example institution in the context of corporate water management. Second, we identify the best-in-class institutions using our quantitative diagnostic analytics approach, and third, we recognize highly impactful practices and association rules using our qualitative diagnostic analytics method. When our DEA models are analyzed with a particular focus on efficiencies, institutions such as Brown-Forman Corporation, Philip Morris International, Kimberly-Clark Corporation, Diageo (UK) are identified as best-in-class institutions. These examples of efficient targets provide a comprehensive set of qualitative diagnostic analytics to aid underperforming institutions in enhancing their sustainable corporate water management practices. These best companies, for example, focus on high operational performance standards and commit heavily to water sustainability. All the efficient companies also note that the reduction of water intensity is an area for continuous improvement. Furthermore, we identify the different driving forces, external pressures, and other factors that may have encouraged these successful practices, as well as the tools used to facilitate their implementation. We find that climate change is the main driving force for Brown-Forman Corporation, Philip Morris International, and Diageo (UK). In addition, Brown-Forman's primary external pressure originates only from local water regulatory frameworks, while other efficient companies deal with additional external pressures, such as stakeholder conflicts, the availability of water, and the effect of water quality on produced goods. Philip Morris and Kimberly-Clark also consider the status of the surrounding ecosystem as they formulate effective strategies. Internal company knowledge, World Resources Institute (WRI) aqueduct, World Business Council for Sustainable Development (WBCSD) global water tools are widely used by our examples of best-in-class institutions in the consumer staples sector. While there are still limitations to this analysis, this framework can be quickly and easily implemented by system analysts and policy makers to better inform their decisions as they guide their institution on the road towards successful, sustainable growth.

Keywords: Sustainable development, Data envelopment analyses (DEA), Formal concept analyses (FCA), Sustainable water management, Disclosure analytics

Using design thinking and Facebook to solve flood problems in remote villages of Morocco

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Abstract

Because of climate change, water levels in the Ourika river in Morocco have risen causing damage to infrastructure and the water supply system. Victims of these disasters must find solutions to adapt to these problems. Floods, like most environmental issues, are complex and malicious problems involving many characteristics, variables, increasing their level of uncertainty. For these problems, there are no rules or list of operations that can facilitate the search of solutions. To solve an environmental problem, its structure and elements need to be defined and redefined in detailed and systemic ways. A creative approach and an effort to understand the short and long term impacts are recommended. How should groups of citizens be accompanied when trying to solve such complex environmental problems? A broad understanding of these problems and a feeling of self-efficacy must be present in problem solvers in order for them to persevere up to the formulation of effective solutions. Two new trends in problem solving inspire the development of approaches to accompany citizens dealing with environmental problems: design thinking and the use of ICT in problem solving. Design thinking, a creative solving approach created by IDEO, is a collaborative way to work during which intuition, abductive thinking, quick prototyping and the consumers' needs are put first. Design thinking which was first used to create industrial products is starting to be applied successfully to improve the quality of the environment. As for ICT, they can now be used to store, share, develop and criticize information and solutions (Facebook, Padlet...). These ICT can be useful for remote groups who want to gather their resources to solve their problems. Design thinking and Facebook were drawn on to accompany ten poorly educated Moroccan women in solving a problem arising from flooding of the Ourika river. The women were taught to use electronic tablets and Facebook. During workshops and through Facebook (when they were separated), women were invited to share their experiences with floods and to find solutions to one of their impacts. Participants quickly mastered these technologies and shared their experience with floods on Facebook with the help of videos and photos. They then chose to together solve the sub-problem of the poor quality of their drinking water, after floods. The thematic analysis of the conversations on Facebook and of the interviews with the participants reveal that design thinking allowed participants to explore many dimensions of the chosen problem and to prototype a certain number of solutions to purify their water. As for Facebook, it was used to share information about the problem (to better define it) and as a communication and brainstorming tool (before and during the water filtration prototype trials). Design thinking and Facebook turned out to be effective tools to pose the water problem more widely, to find solutions adapted to the participants' living conditions and to improve their self-efficacy in problem solving as well as their collaboration.

Keywords: floods, problem solving, design thinking, Facebook, Moroccan women

1. Introduction

Millions of people are currently feeling the impacts of environmental degradation. When confronted by floods or droughts, for example, they must find ways to mitigate risks to their health, their families, and their property. Through the work of subsidized projects, diverse organizations guide those people in solving the problems with which they are faced.

For instance, scientists working with social groups reflect on flood adaptation strategies. All of the contributors aim to help these groups recapture their quality of life and a healthy and viable environment. What is the best approach to facilitate the development of original, effective, and realistic solutions among victims of environmental problems? Indeed, external stakeholders have a poor understanding of the victims' experiences, context or the cultural and material constraints. A collaborative problem-solving approach imposes itself such that the issues must be defined and solved together by the affected persons and their guides. In addition, these complex and malicious problems encompass a wide range of characteristics (causes, area, actors, impacts…, Pruneau and Langis, 2015), interdependent variables (Jonassen, 2000), that change rapidly and increase their level of uncertainty and difficulty (Pourdehnad et al., 2011). For these problems, there are neither rules nor a list of possible actions that might facilitate finding solutions. Environmental problem-solving requires defining and redefining its structure and aspects in both detailed and systematic manners (Irwin, 2000; Thakker, 2012). A creative approach and an effort to understand the short and long term impacts are recommended (Dos Santos, 2010). Indeed, ***creative*** problem-solving is vital in tackling global issues such as climate change, pollution, or environmental diseases. As mentioned by United Nations (2015) in their new Sustainable Development Goals (for 2015-2030), different practices are needed in today's world: renewable energy, efficient transportation, healthy cities, resilient agricultural systems, etc. Therefore, it is important to develop collaborative, creative, and effective approaches to help groups in addressing environmental issues.

To build these support processes, the literature offers two types of problem-solving approaches: the scientific approach by which we discover the laws that govern the natural world and, more recently, design thinking with which we invent a different future (Liedtka, 2000). The scientific approach calls upon inductive and deductive reasoning to solve closed problems such as researching the position of a star in a given annual period. In the scientific approach, problem-solvers are distanced from the object of study (Dos Santos, 2010). However, when solving complex problems such as identifying climate change adaptation strategies, it is necessary to add another competence: abductive thinking, which consists of imagining things that could work. Design thinking, during which the problem-solvers immerse themselves in the object of study's environment, calls upon inductive, deductive, and abductive reasoning. It would be productive in situations where there is uncertainty. In 2006, IDEO launched a creative problem-solving approach called *design thinking*. Since then, this approach of innovation, adopted by numerous corporations, fostered the development of efficient and original products: ICT applications (Apple computer mouse); engineering and scientific articles; educational innovation. IDEO also inspired the development of a number of creative problem-solving approaches: the Innovation Lab, Strategic Design, Transformational Design, Human-Centered Design… Design thinking is a creative and collaborative method of working in which intuition plays an important role, solutions are numerous, experimentation happens rapidly, failures are perceived as learning opportunities and, mostly, the needs of consumers are considered (Liedtka and Ogilvie, 2011; Lockwood, 2010). Design thinking applies the sensibilities and methods of the designer to complex problem-solving. Indeed, designers routinely deal with complex problems by generating various options that are progressively refined through testing. As part of a rigorous process, and with the use of well-defined tools, design thinking calls upon both creative and analytical thinking (Lietdka, 2015). It follows a number of defined steps: 1. Observation-inspiration: we conduct an ethnographic study to understand the individuals concerned with the issue and the situation. This is achieved by following them in their daily lives to better grasp their aspirations and unmet needs (pain points). 2. Synthesis: the problem is defined and redefined several times and in different ways. The goal is to uncover information and various perspectives on the problem. The information is synthesised to express the problem in concise statements and with the use of visual aids. 3. Ideation: we generate a number of ideas and select a certain number. 4. Prototyping: we quickly build prototypes to illustrate the proposed ideas and share them with others to evaluate their potential in both form and function. 5. Testing: the prototypes are assessed by gathering the opinions of experts, novices, and users. The winning prototypes are refined (Scheer et al., 2012). 6. Communication: we make the product known (Brown, 2009). Seidel and Fixson (2013) summarise the design thinking process in the following way: extensive research on consumer needs; brainstorming to generate a number of ideas; and, prototyping to test and select the best ideas. The steps in design thinking are not entirely linear since the focus of designers meanders between the problem and the solution while empathy for consumer needs deepens and the best solution is refined. The process – which is first divergent and then convergent – is centered on human needs. Prototypes that are developed quickly and without seeking perfection become “playing fields” that foster discussion and learning about certain solutions (Liedtka, 2015). As such, the problem and the solutions co-evolve (Dorst and Cross, 2011).

Design thinking – initially used to develop commercial products – is now used to foster human flourishing and environmental health. Among movements such as *Design for Life* (Buchanan, 2001) and *Human-Centered Design*, and NGOs such as *IDEO.org* and *MindLab*, the focus is on developing processes favourable to quality of life and the eradication of poverty. Accompanied by these organizations, individuals grappling with these issues collaborate during some of the design thinking steps (steps 1 and 5, and sometimes more). The positive environmental transformation and humanitarian effort are thus recently at the heart of design. Because of the deductive, inductive, and abductive (imagining what *could* be) reasoning that places demands and potentiates the development of creative solutions, design thinking and its variations (Innovation Labs, Transformational Design…) may be useful as support processes for groups engaged in solving environmental problems (Pruneau and Langis, 2015). Indeed, Pruneau et al. (2014) have typically observed the presence of design thinking among numerous leaders in sustainable development.

Moreover, with design thinking, specialists now have access to technological tools that support citizens in problem-solving at times when they are remote. Indeed, there are current ICTs that might be used during different stages of problem-solving: to share opinions and information about a situation (*Stormboard, Narrative Clip*); to summarise information (*Popplet*); to consult experts (*Skype*); to propose and comment on ideas (*Padlet*); to vote (choose among ideas, *Loomio*); to sketch prototypes (*iDroo*); to plan (*Wrike*); and, to communicate (*Facebook, Glogster*) (Pruneau and Langis, 2015). Some research has demonstrated the potential of online brainstorming: quick, independent, and simultaneous sharing of ideas; motivation; time to reflect and allow ideas to ripen; creativity… (DeRosa et al., 2007). Digital tools used in design thinking have yet to be properly evaluated with respect to their ability to facilitate problem-solving in general or for environmental problems.

The strengths of design thinking could indeed be found in its deeper definition of the issue under consideration; in taking real customer needs into account; in its prototyping (which allows for the optimal development of ideas); and, in a better consumer adoption of the solutions found. Given its novelty, design thinking and its enablers have not yet been properly studied, particularly in collaborative environmental problem-solving. It is thus within the scope of this reflection on accompanying citizens facing environmental problems that an exploratory case study was led in Morocco with low education rural women grappling with devastating floods. Leveraging design thinking and Facebook as a networking tool, ten women from the Ourika region were accompanied in their research on adapting to the frequent flooding of the river. The two research questions that were asked were the following:

- *How could design thinking help groups define and solve environmental problems with which they are faced?*
- *How could Facebook facilitate collaborative environmental problem-solving?*

2. Methods

To answer the research questions within the context of the major GIREPSE (*Gestion intégrée des Ressources en Eau & paiement des services environnementaux*) project, an exploratory case study in Morocco was carried out with 10 women from the remote and impoverished Ourika region. The women were selected based on their reading and writing abilities (minimal) and hailed from six remote villages (Aghbalou, Timalizen, Amlougi, Oualmes, Tazitount and Setti Fatma) located in the Ourika region, approximately 35 kms from Marrakech. The regional economy in Ourika is based primarily on agriculture and livestock breeding. Industry and mining, tourism, and the arts also make up an important part of the labour force. Over the past few years, floods of the Ourika wadi have increased in frequency and intensity in conjunction with climate change. These floods have devastating effects on the landscape, agriculture, human capital (injuries, deaths), infrastructure (roads, bridges), and food security (water, food). The women, who are the family guardians while their husbands work in Marrakech, are often tasked with confronting the floods and protecting their families and property.

The interventions with the women took place over a period of seven months, during which two minor floods of the Ourika occurred. The design thinking approach dictated the activities organised with the women, and Facebook was used for networking while we were away from the women. During the first two phases of design thinking (*observation-inspiration* and *synthesis*), individual interviews were conducted with the women to capture their descriptions of the major flooding problem and their needs in the face of disaster. A *Journey Map* visually representing their daily life before, during, and after a flood was prepared by our team of researchers. In preparing for floods, the women said they stored wood and food staples (wheat, oil, vegetables…) to avoid a shortage in the case of road closures. They lay plastic on the roof of their houses and filled the holes with dirt to prevent water leakage. Some dug small canals in front of the house to divert the current and prevent water from invading the house. During flooding, they moved family belongings to a room that was less prone to immersion, and some took their children and sought refuge with neighbours or acquaintances. Following the floods, they cleared the roads covered in rocks and dealt with problems in the water supply. Indeed, the sediment-laden water was placed in plastic jugs so the debris could settle at the bottom. After settling, the water was then consumed or used for other domestic purposes.

During the two initial two-day workshops with the 10 women in August 2015, the *observation-inspiration* and *synthesis* phases of design thinking were put to the test and facilitated in Arabic by a researcher from our team. The women were encouraged to complete the previously prepared *Journey Map* together and share their experiences of the flood. They were also trained on how to use tablets and Facebook. Next they chose to work on a smaller problem that was easier to solve: the quality of their drinking water following a flood. The exchanges on Facebook stretched from September to November with communication flowing through the social network between the women and our team about the underlying problem of post-flood drinking water. At the outset, the women were asked to post pictures, videos, and comments on Facebook about flooding (in general). Next, the women were asked specific questions in order to define the underlying problem of water quality after flooding: *Where? When? Why? Impacts? Solutions?* etc. The women were to observe the problem in their village and answer the questions using the tools available on Facebook: comments, videos, pictures… The women met again for the third workshop, held on one day in November 2015, to complete the *synthesis, ideation, prototyping,* and *testing* phases of design thinking on the issue of water quality. During this workshop, a summary of the facets of the drinking water problem and solutions proposed on Facebook was completed. Water collected from the wadi in the villages was then tested with the women for its quality: pH, coliform, bacteria, etc. The women were also invited to invent filter prototypes by using materials available in or around their homes: fabric, coal, plastic bottles, sand, rocks… They were also required to verify the filter's ability to purify the water. Following the third workshop, the Facebook exchanges resumed from November to January and planned according to the *prototyping, testing*, and *communication* stages of design thinking. The women tried to construct their own filters at home and shared their trials on Facebook so they could receive feedback from their peers. On Facebook, an overall assessment of the solutions identified concluded the exercise.

In order to address the two research questions during the design thinking process, individual and group interviews were conducted with the women, and their use of Facebook was analysed. During the interviews, the women were asked open-ended questions. Here are some examples: *Tell me about your experience with Facebook since the beginning of the GIREPSE project. What do* *you like about the Facebook group? What value do you feel is added by using tablets for the GIREPSE project? How do you feel the Facebook group helps in solving the problem of drinking water following floods?* etc. The data was subjected to a thematic analysis carried out by two researchers, both individually and together. The emerging themes represented the women's views on the water problem, the quality of their solutions (using fluidity, originality, and effectiveness as criteria), the knowledge they have acquired, their emotions, their participation (active or not) in networking, their types of communication, their empowerment, and their collaboration.

3. Results and Discussion

First of all, it should be noted that the effects of the selected method (design thinking) along with Facebook might be difficult to differentiate as they are complementary tools. Table 1 shows qualitative and quantitative data on the women's participation in the Facebook network.

Table 1. Women's participation in the Facebook network

Month/ week	**Total number of posts**	**Type of activity on the Facebook group (pictures, videos, text…)**	**Average number of comments per post**	**Average number of "likes" per post**
January				
Week 1	10	Text, pictures, and videos	5	3
Week 2	9	Pictures and videos	5	6
Week 3	6	Pictures and videos	3	3
Week 4	5	Text and pictures	5	5
August				
Week 1	3	Pictures and videos	2	4
Week 2	19	Pictures and videos	2	5
Week 3 up to the 31st	17	Pictures, videos, and text	1	12
September				
Week 1	3	Pictures, videos, and text	6	15
Week 2	4	Pictures, videos, and text	8	3
Week 3	4	Pictures, videos, and text	5	3
Week 4	13	Pictures, videos, and text	4	7
October				
Week 1	3	Pictures and text	9	3
Week 2	2	Text	10	3
Week 3	1	Text	25	4
Week 4	1	Text	10	3
November				
Week 1	1	Text	6	5
Week 2	2	Text	9	2
Week 3	Workshop in Morocco	Workshop in Morocco	Workshop in Morocco	Workshop in Morocco
Week 4	8	Text and pictures	1	5
December				
Week 1	1	Text	2	4
Week 2	3	Text, videos	6	3
Week 3	5	Pictures and videos	3	4
Week 4 up to the 31st	4	Text and pictures	4	3

As demonstrated in Table 1, these women with low levels of formal education were for the most part able to take advantage of various tools available on Facebook – pictures, videos, text, comments, “likes” – and did so regularly. The posts with pictures and videos showing the reality of the two major floods were very popular. The women seemed mostly happy to share, with the help of photos and short videos, the scope and the impacts of the floods in their respective regions. They also chose photos and videos to illustrate the prototypes of the filters that each of them built. Writing texts describing the various aspects of the problem (regions, causes, impacts…) was a challenge for these poorly educated women but they nonetheless actively participated to the gradual definition of the problem by answering to the best of their abilities to weekly questions. Comments on other women’s posts, as well as « Likes » were more abundant at the beginning of the Facebook Group’s existence. At the end of the seven-month period devoted to the problems with their drinking water, motivation to participate to the Facebook Group seemed to have decreased, except following another flood in the Ourika. This flood triggered postings of new videos and photos from some participants.

Table 2 shows the main collaborative learning that participants said were made during the project

Table 2. Collaborative learning reported by the women

Types of learning	Acquirements
Techniques	- Use tablets and Facebook to communicate
Environmental	- Expand their knowledge on the water quality
	- Became aware of the poor quality of their drinking water
	- Accomplished flood adaptation measures : better choose their water source, improve water filtration, alert others when a flood arises.
Geographic	- Know the other villages and what is happening with their water
	- Learn what is going on in the world and in their country
Social	- Make new friends
	- Be part of a network that wants to improve the future of villagers
	- Communicate one’s ideas and feel like you are being heard
Practical	- Better choose their water source
	- Know how to clean and conserve their water

During individual and group interviews, the women shared with us that the input from the other women and the facilitators helped them learn a number of things: learning how to use tablets and Facebook; gaining a detailed understanding of the problem with water quality; knowing what was happening with water in other villages; becoming aware of the poor quality of water they consume; having solutions; being able to choose better water sources; learning how to purify and conserve their water; and, gaining an awareness of what is happening in their country and in the world. With respect to communication, they mentioned feeling less isolated and part of a friendly network sharing news about themselves while collaborating on adapting to flood conditions. Indeed, when a flood is about to occur, women living upstream warn those living downstream of the incoming flood. The women also privately share their views on a range of local issues. On an emotional level and linked with empowerment, they mention how much they enjoy sharing their ideas with the group and being heard. They also state feeling motivated and capable of getting involved in solving other problems, such as the polluting behaviours of fellow citizens who toss their household refuse into the Ourika and ruptured drinking water pipes during floods. They would also like to pursue the approach initiated by the group to improve flood adaptation. Lastly, they enjoy sharing what they have learned with their families, friends, and fellow citizens from the village.

We noticed a growth in the way in which the women discussed and understood the major flooding problem and underlying water quality issue after a flood occurs. They now identify various aspects about the nature of the problem (the Why): “The floods arrive suddenly and take away everything in their path.” “The heavy rains and floods destroy the drinking water pipes in the villages.” “Water becomes unavailable. We must drink dirty water from the wadi or find other sources.” “After the floods, the water is highly polluted. Its colour and odour change.” “The traditional methods (purifying water by adding chlorinated water and allowing it to settle) are ineffective.” They are aware of several impacts due to flooding: “Despite its poor quality, residents use well-water for drinking and cooking. After consuming it, some residents – especially children and the elderly – suffer from fever, diarrhea, kidney and stomach infections, allergies…” They know about new causes of poor quality drinking water: “The floods carry rocks and sediment which dirty the water.” “People toss garbage on the riverbank. It is worse during tourist season and near restaurants. The garbage mixes in with the flood water.” Finally, they have a lot more to say about the aftermath of a flood: “After a flood, the water remains polluted for a week or more depending on the weather conditions.” “The pipes are left broken for about fifteen days.” “The water is dirty even after the pipes are repaired.”

This growth in their understanding of the problem-space seemed to directly influence the solutions they proposed on Facebook. Here are a few examples: “Find better water sources.” “Build a water storage structure to ensure delivery to residences.” “Treat well-water with appropriate quantities of chlorinated water.” “Raise awareness so people stop dumping garbage in the river.” “Build solid pipelines.” “Build wells far from the river and flood zones.” “Filter the water before it reaches the tap.” We notice that some of their solutions are aiming to eliminate causes of the problem (proactive adaptation) while others are in reaction to the impacts of the problem (reactive adaptation), which demonstrates a deepened understanding of the problem that needs to be addressed.

In meeting the challenge of purifying contaminated water using handicraft filters made from household materials, the women built prototypes that turned out to be moderately effective (according to us). The prototypes built by the women made the water a lot clearer but did not necessarily eliminate coliform and bacteria. Here is an illustration of a typical filter built by the women using a plastic bottle, a sieve, coal, sand, stones, and fabric (see Figure 1).

Figure 1: Example of a filter prototype built by the participants

In this case, it turned out to be a significant challenge, given the poor variety of filtering materials available in the Ourika houses and given the limited scientific knowledge of the participants. However, the women claimed to be satisfied with the new filtration methods since, prior to this, they would simply let the water settle and consume it immediately, which was making the children sick. When the water becomes polluted during future floods, they claim that they will use these types of filters and these raw materials to purify the water. The filters as constructed do not entirely satisfy the research team but seem to please the study's participants.

4. Conclusions

In conclusion, we can assert that the approach used (design thinking + Facebook) allowed the women to define the major flooding issue and the underlying water quality problem in broad and detailed terms, based on their own needs. While not necessarily original, the solutions proposed by the women were varied (fluidity), realistic, and with a level of efficacy (according to them). The tablets and Facebook fostered the creation of a social network that was strong, engaging, and effective in defining and solving a local problem in a collaborative way. The women came out of isolation, learned to communicate their ideas, felt like others were listening, and collaborated well. Thanks to the social network and workshops, they learned a number of things such as the flow and precise locations of the floods, the causes, the impacts (both short and long term), the ways in which other women managed water, the quality of the water they consumed, as well as techniques to purify and conserve drinking water. Prototyping water filters seems to have motivated them to learn and act locally. The approach in general modified their water consumption behaviours. They established proactive and reactive adaptations to flooding: better choice of water sources; better water filtering; building a support network; and, warning others when floods are arriving. Finally, the project fostered a sense of self-efficacy among the participants: they believe that together, they can make a difference in their way of life.

To deal with floods and their impacts, the women will need to gradually address other underlying problems related to flooding: ruptures in drinking water pipes; the behaviour of citizens who toss their garbage into the river; the possibility of deviating the water flow so that flooding bypasses villages… all of which demonstrate the significant complexity of environmental problems and the tremendous challenges when trying to adapt to extreme weather events caused by climate change. This project reinforces our opinion that solving problems linked to climate change requires a mentoring approach that is detailed, creative, and engaging that stretches over a long period of time since new underlying problems appear while trying to solve the primary one. Given the difficulty in solving environmental problems, design thinking facilitated by a Facebook group as demonstrated appears to provide good results and fosters numerous solutions, which are not perfectly effective, but improve the women's ability to adapt to flooding. According to us, in a country where women are largely unrecognised for their ability to solve problems, the combination of design thinking and Facebook allows the women to express themselves and be heard.

However, we believe that the empowerment of our female participants still requires more time to be fully realised and perceived by their peers.

This research reinforces the idea promoted by Mazman and Usluel (2010), Ajjan and Hartshorne (2008) and Mason (2006): Facebook is potentially beneficial for interaction, collaboration, information and resource sharing. In this case study, Facebook was mainly used as a communication tool, and mostly in the problem space, to share opinions, information, and solutions related to one issue. Future research should focus on discovering ways to leverage Facebook for other uses linked to problem-solving with design thinking: summarising information, consulting experts, voting (choosing among different ideas), and planning tangible on-site adaptation strategies. This would bolster all steps of design thinking and allow deeper work in the solution space, which may result in original and more effective solutions. To increase creativity, other online brainstorming tools (*Padlet, Popplet, Mind 42, Loomio…*) might be used favorably in solving environmental problems, which was not possible in the current research given the novice ICT abilities of our participants.

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Territorial knowledge management for socioecological transitions: "smart" vs "territorial intelligence" approaches in Mexican and South European contexts

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Abstract

This paper carries out a comparative study of several territorial participatory knowledge management projects (collection, storage, analysis, display and sharing of socio-ecological territorial information) in two research centres, LAST (Socio-territorial Analysis Laboratory, Universidad Autónoma Metropolitana- Cuajimalpa, in México City) and C3IT (International Research Centre of Territorial intelligence, Huelva University, Spain). Both of them are associated with the International Network of Territorial Intelligence. The paper analyses two alternative scenarios in the evolution of territorial knowledge management according to different trends in production and uses of the ICTs in the framework of socio-ecological transitions. The first one, the "Smart" one, is drawn in the horizon of current digital technology trends and its general dissemination in the context of cognitive capitalism. The second one, called "Territorial Intelligence", aims to foster collective intelligence and lateral multilevel governance in territorial decision-making processes facing socioecological challenges, bringing about technological production and uses for more open, organic, artisanal and participatory ways of cooperative knowledge management. The paper is divided into three paragraphs. The first section discusses general figures of cognitive capitalism that prefigure both scenarios. The second one discusses the role of the ICTs and knowledge management and describes the two aforementioned scenarios according to relevant literature. The third section analyses, according to the main characteristics of both scenarios, diverse collaborative processes of the co-construction of territorial knowledge in both research centres. The study compares the methods, outcomes, potentialities and limits of these projects in order to foster territorial actors' co-produced knowledge appropriation, capacities and empowerment. The conclusion points out complex overlapping situations on the ground as well as the short term duration and financial instability or institutional support of current experiences. The final section proposes some recommendations for a better integration of both approaches in order to adapt the ICT's uses to each territorial context and in order to promote the sustainability of these collaborative processes of knowledge production and management.

Keywords: Territorial intelligence, Smart cities, Smart regions, socio-ecological transitions, participatory governance.

A distributed system approach for design of environmental monitoring systems: Opportunities and Challenges

Eun Ji Cho and Wanlin Zhang

Abstract

Distributed systems, defined as "*sociotechnical systems that are scattered in many different but connected, relatively autonomous parts, which are mutually linked within wider networks"* (Manzini, 2015) have gained attention over the years as a promising model for sustainability, especially in areas like renewable energy production and food production. This paper investigates the potential of applying the distributed systems approach to the field of environmental monitoring, with a strong emphasis on citizen participation. Crowd sensing initiatives like the Smart Citizen kit – a set of a sensor and a mobile application which enable citizens to monitor the quality of their environment, ranging from air quality to noise level, and share the data with other users around the world through an online platform – have shown the potential of distributed production of environmental data. By employing case studies and a field study, this research aims to produce design-specific knowledge for the development of distributed environmental monitoring systems, differentiated from the design of centralized systems. Findings from a literature review on the key characteristics and applications of distributed systems, and case studies of citizen science projects for environmental monitoring are presented. A field study focusing on water quality monitoring was carried out by a team of design researchers, in collaboration with local NGOs, for two weeks in Qinghai – Tibetan plateau in China. As the headwaters of several major rivers are located in Qinghai area, water quality in this area has a critical influence in the many Chinese cities as well as in the quality of life of local residents who use the river water for daily needs, including drinking and cooking. The field research aimed to study current ways of water quality monitoring in Qinghai, and to explore possible ways to develop a participatory system in which local residents and other stakeholders can act as nodes of distributed monitoring system. Based on the findings from the field study, such as local people's nomadic lifestyle, a sense of community, and a strong role of religious leaders in environmental protection and collective action, a concept of product-service-system for local water quality monitoring is proposed. Drawn from case studies and the field research, potentials of a distributed system approach for environmental monitoring and protection, and design strategies for the development of a distributed environmental monitoring system are discussed.

Keywords: distributed systems approach, environmental monitoring, citizen participation, product-service-system

Track D. African Perspectives on the Old and New World Challenges for Sustainable Development

Session 0D-05

Session 0D-06

Session 0D-08

Views of local communities and indigenous people on Congolese rainforest sustainable management reform

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Abstract

The Congo Basin detains the second most important rainforest in the world, most of which is located in Congolese territory. Its multiple values at local, national, regional and worldwide levels appeal to many different interests that may be complementary but also concurrent or even contradictory. After a long period of political instability, the Democratic Republic of the Congo launches in 2002 a reform of its extractive sectors that aimed to improve the country's governance and to ensure economic growth, while allowing a more balanced distribution of revenues and assuring the protection of the environment, and thus create the bases for the construction of the country's sustainable development. As it aims to balance the economical, social and environmental pillars, the development of a sustainable management of this huge patrimony must take into consideration the different parties or interests and associate to the process the multiple actors at steak, specially those who live in the forest or depend on it for their daily survival. Through interviewing some of these actors we find out they have different perceptions of the forest and its values, which will lead them to different definitions of the objectives to achieve and of the politics that should be pursued to effectively protect the Congolese rainforest but also to assure a dignifying way of living for its inhabitants. We tried to analyse how, having been mainly designed under an external perspective, the reform doesn't seem to have really taken into account the difficulties its application could lead to on the field and even less the effective power each actor; specially local community members and indigenous people, detains over different but essential elements of its success. The relations that have been developed between stakeholders seem to have reinforced each one's conviction on the need to defend their own individual interests without really understanding the global process aim and making even more difficult the effective sustainable management of the Congolese forests.

KEY WORDS: rainforest, sustainable management, Democratic Republic of the Congo, indigenous people, local communities.

1. Introduction

Since peace has been re-established in the Congo in 2002, the country, guided by the International Community, has started a legal reform of its extractive sectors, namely the forest one, aiming to translate into the national law the international principles of sustainable development, as preconized by the Brundtland Report and the subsequent United Nations (UN) summits.

Tropical forests are essential to humanity, namely because the role they play in controlling climate change and preserving biodiversity. Congo Basin Forests, in particular, provide subsistence means to 60 million people and assume important social and cultural functions.

The Democratic Republic of Congo (DRC) has a 2.344.858 km^2 territory, 68 % of which is covered by forest areas. The country is extraordinarily rich in natural resources but fails to attain its development needs, being presently poorly classified in the Human Development Index, although having moved from 186th over 187 countries in 2013 to 176th over 188 countries in 2014. Its hunger index for 2009 (last available data) is considered as extremely alarming(Welt Hunger Hilfe; IFPRI; Concern Worldwide, 2011).

The PNUD 2015 report on the Millennium Development Goals achievements describes a national context undertaken by regular armed conflicts, massive populations displacements and natural and constructed patrimony destruction that makes it difficult for reconstruction and development to take place (PNUD, 2015, p. 85). Human Rights Watch considers that information and security services keep exercising severe repressive measures against activists and regime opponents and that the extremely violent situation in the East Country is a matter of concern (Human Rights Watch, 2016).

The forest sector should play a major role in contributing to the country's economic recovery, through taxes, investments and jobs creation from the logging companies, but also from conservation and touristic programmes that were to be implemented if the country's security levels and making business rankings were able to assure the needed conditions for these activities to develop. The Congolese forest reform launched by the policy review in 2002 aimed to place the forest as a key element of the country's sustainable development construction, trying to balance economic and environmental goals with social needs and expectations through participated decisional processes.

This paper aims to describe and analyse the perceptions of local communities and indigenous people from villages located in a forest logging area in DRC over key issues on the national forestry reform, such as:

1. the Forest Code(Présidence de la République, 2002), which constitutes the basis law on the matter;

2. the positive and negative impacts of forest logging;

3. the right of local communities and indigenous people to participate on decisional forums, effectively managing the forest in which they live.

Those of two indigenous people representatives based in the country's capital, Kinshasa, complement these perceptions.

All the data will be related and confronted with the main objectives of the reform, which has been designed in order to implement the sustainable management international principles and thus to assure the sustainable management of the Congolese rainforest itself.

In the first section of this article, we try to summarize the methodological principles that guided our work and to mention its limitations. We then locate the fieldwork and describe the Congolese context regarding the social dimensions related to the forest, as well as the forest's importance in this regard. We finally present the main results of the study and at last the conclusions.

2. Methodology

This is a qualitative research, justified by the need of taking into account the global reality and to value the context and the reference framework in which subjects act; we tried to reduce the importance of the researcher in order to produce a rigorous data description (Carmo & Ferreira, 2008).

We proceeded by a bibliographic survey of technical and scientific texts regarding the sustainable management of the tropical rainforest, the processes of citizens' participation and specific questions related to indigenous people. We also reviewed the Congolese legal framework, including the international conventions and treaties the country subscribed. Working in a forest logging company, it was possible for us to informally discuss these subjects with many actors taking part in the forest reform process, from local to national authorities, industrial managers and workers, civil society representatives, national and international NGOs and conservation agents.

We interviewed people in four villages, Ikala I, Ikala II, Duma II and Sapeza, the latest being an indigenous people community, located in two logging concessions of SODEFOR, sprl., on the Lukenie river in the Bandundu province. Both concessions are presently working and the company has signed compensation agreements with local communities, complying with legal demands. We also interviewed two indigenous people representatives, based in Kinshasa, who usually participate in discussion and decisional forums concerning rainforest management and conservation.

All the interviews were semi-structured, following a basic guideline, and were recorded; each intervenient has been informed of the interview's purpose. Records were analysed with he critical discourse analysis, since it seems the most adequate methodology to identify the several meanings created by discourses, as well as the socio-political representations and the power relations they traduce, in a permanent dialectic between the discourse and the society, that also allowed us to take into account the external origin of the sustainable development narrative:

> *"as everyday lives become more pervasively textually mediated, people's lives are increasingly shaped by representations which are produced elsewhere. Representations of the world they live in, the activities they are involved in, their relationships with each other, and even who they are and how they (should) see themselves"* (Fairclough, 1999, p. 75).

We are aware that some biases may have been introduced in this study by our scarce lingala knowledge, that obliged us to appeal to translators on the field, and by the fact that several community members were present in the room when the interviews were taking place, which may have conditioned people's answers to the questions. On the other hand, as we interviewed three people per village (one adult man, one adult woman and one young representative), our perception of the villagers' opinions has been enriched by these audiences.

3. Why does DRC's forest matter?

3.1. One forest, many needs, several concerns

The Congo Basin Forest is the second largest tropical rainforest in Africa and the second largest in the world, right after Amazonia(Debroux, Hart, T., Kaimowitz, D., Karsenty, A., & Topa, G., 2007). The DRC's forest area covers on its own 145 million hectares and assumes several important functions at the local level, by furnishing food, pharmacopeia, fuel and construction wood and by assuming cultural, ritual and religious functions. It is also of main importance at the national, regional and international levels as it contributes to the country's economy, essentially by wood trade, it has a huge potential for biological and pharmaceutical research, it contributes to hydric systems and climate regulation, and it should play a major role in biodiversity conservation.

The State of the Forest 2013's edition (de Wasseige C., Flynn J., Louppe D., Hiol Hiol F., Mayaux Ph. (ed.), 2014) identifies the main deforestation drivers in the Congo Basin forests as being the slash and burn agriculture, the artisanal logging and the production of fuel wood. The same analysis had already been presented by the World Bank concerning the Congolese forest: "deforestation and forest degradation through shifting cultivation, fuel wood and charcoal production, illegal small-scale logging and commercial logging (in that order of importance) are particularly high in the DRC (…)" (Tollens, 2010, p. v). In DRC case, it is important to take into consideration that only 9% of the population has access to electricity, which leaves millions of Congolese dependent on fuel wood, main charcoal, for the satisfaction of their daily energy needs

It is also important to mention that DRC has an estimated 70 millions inhabitants, including approximately 600 000 indigenous people, and presents a demographic growth of 3% per year; the country detains one of the highest fecundity rates in the world, attaining 6,6 per woman (PNUD, 2015). There are big disparities between rural and urban areas, as well as between provinces, namely in what concerns the incidence of poverty, which, in 2012, rated 63,4% for the country but attained 80% in the poorest provinces (PNUD, 2016); this leads to also very high levels of hunger with 42,1% of the children under 5 years old suffering from malnutrition and with 38% of the households presenting poor nutritional consumption levels(PNUD, 2015).

In this severe context, an estimated 35 million Congolese depend on the forest on a daily basis for the satisfaction of their basic needs (Trefon, 2006, p. 103); the population growth demands larger food supplies and the augmentation on food production implies the conversion of forests into agricultural fields, leading to further deforestation. These needs and their consequences can not be ignored during policies definition and implementation and people's perceptions on the forest's importance are clearly related to their survival dependence towards it.

3.2. Many values, many actors

As already said, the forest sector reform aimed to implement the sustainable development principles into the Congolese law and into management practices in the country. The economic, environmental and social pillars were thus included in the norms and the forest has since been regarded in its many values and not only for the economical one. The conservation of the extraordinary patrimony it constitutes became on of the main objectives in policy definition, associated with population rights and biodiversity protection. The present concept of forest effectively translates a space of multiple values, as farming and hunting territory; shelter and pharmacopeia provider; energy source; historical, cultural, and identity construction patrimony; sacred, mystical, religious and ritualistic place; biodiversity reserve, regarding species, ecosystems and genetic diversity; hydric regulation system and climate regulation system.

These many values coexist in the same space and are coveted by different actors, who possess different perspectives concerning their importance and different expectations regarding the possible benefits to be obtained:

> "(…) *the service providing ecosystems are essential for human well-being. Functions will differ in accordance with region-specific and personal factors of the stakeholders grouped in the societal subsystem. These specific characteristics will determine the values stakeholders attach to the environmental services (social, financial and economic, ecological…) (…) "In most cases a single ecosystem service will support different stakeholders. Consequently, different and even opposing values can be attached*" (Rutten & Mwangi, M., 2014, pp. 65,66).

Public policies in forest management must take into consideration the absolute need of combining these different interests in a balanced way; otherwise the implementation of the legislative prescriptions will not effectively take place, no matter how strongly they are inscribed in law and norms.

There are several actors actively involved in the forest management process and reform. One is the State, who the law identifies as the only possible forest owner, because in DRC the soil and the subsoil belong to the State and cannot be alienated. In this particular case, the State has been guided by the International Community who induced the reform by conditioning the liberation of a Poverty Recovery Credit to its implementation.

Another important actor are the conservation institutions, which frequently pursue their own objectives taking little account of the context and of the possible consequences the policies they design and try to implement may produce: "they would prove to be one of the most highly centralized exercises of defining forest use ever, created not at a national level or at the seat of a colonial power, but from a few cities in a handful of northern developed countries"(Larson et al., 2010, p. 30).

A third actor we must consider is the population, which does not constitute an homogeneous group in itself but rather multiple groups separated by gender, age and ethnic or territorial issues; those are major questions to consider when determining the stakeholders taking part in the forest management process and that is why it is necessary to investigate "who <the people> or <rural people> are, what constitutes local and community in the light of ideas and issues of commoditization and social differentiation, and to incorporate questions of whose environments and whose livelihoods in seeking to tell (and explain) environmental change like it is"(Bernstein & Woodhouse, 2000, p. 197).

3.3. Mixing it all together in participation

Participation became a fundamental concept in discussing natural resource management from a sustainable development perspective. The connexion between high levels of poverty and negative consequences to the environment has been described since the Brundtland Report, which identified fight against poverty and engagement of different stakeholders as *sine qua non* conditions for the success of any environmental policies.

Community based natural resource management “is fundamental premised on institutional reforms that decentralized authority over – and benefits from – land an natural resources to local actors”(Nelson & Agrawal, 2008, p. 558). However, the concept of participation has been object of numerous debates for its elastic capacity that allows multiple definitions and interpretations, often tending to legitimize processes that are not really that participated(Schiefer, Bal-Döbel, Batista, Döbel, Nogueira, & Teixeira, 2006).

Another important issue is the means by which are determined those who effectively participate and, subsequently, those who are kept out of the participation forums and arenas. Although legal definitions and prescriptions determine the need of all parties to be represented, “bantu men, the elders, control power and they alone decide how the community should preserve its past and organize its future. Women have no voice. Pygmies have no voice (…) these exclusions are serious handicaps to the Congo’s broader development needs” (Trefon, 2006, p. 110).

On the other hand, it is important to understand in what processes is participation occurring and for what purposes, as development needs and environmental policies are often externally designed and rural bases do not seem to have the power nor the capacity to drive bottom-up proposals concerning their needs and aspirations.

> “funding constraints also continue to hamper the growth of civil society. The little funding that is available often comes from foreign sources. This reproduces the problems of aid agendas and dependency. Another form of dependency is the dominance of urban elites who claim to represent rural communities but who in reality are disconnected from their rural bases”(Trefon, 2011, p. 128).

3.4. What do forest people say?

Our first goal was to understand what do forest people know about the Forest Code and how do they perceive it. Since we were working in villages concerned by logging activities, the basis law was supposed to have been vulgarised by mandated NGOs, who should assure people were aware of their legal rights and ready to discuss them with the enterprise.

We came to understand that the law, as a formally defined concept, is rather unknown from these communities, as the vast majority of those interviewed affirm not even having heard about it or knowing it exists but not what it says. A village chief affirms to be familiarised with the law but is incapable of describing it or its fundamental principles. The indigenous people representatives in Kinshasa have opposite views on the quality of the law, one of them affirming his people weren’t present during the redaction process and for that reason international community and signed conventions recommendations were not taken into account in what concerns the defence of indigenous rights. In Sapeza village, home of Twa pygmies, the existence of a general law concerning the forest seems to be unknown.

The purpose of assuring the participation of all the actors at all different levels as defined by the Forest Code is therefore undermined by the persisting ignorance about the text itself.

We also tried to perceive people’s understanding and evaluation on the social clause, a mandatory agreement signed between the company, the state and the local communities and / or the indigenous people concerned by the logging activities, that must take place prior to any effective forest harvesting. In this case, we obtained several different answers but all of them revealed a superficial knowledge of the subject, namely about the negotiation proceedings, the obligations of the parties and the definition of the counterparts itself, as if the agreement had been celebrated between the company and the local leaders and did not concern the community as a whole.

Two women identified the social clause as a compensation agreement for the harvesting of trees in the community’s forest and a third one showed her disapproval regarding the process, justifying her ignorance on the document with the exclusion of women from participation processes. The same reaction and argument was registered from a young interviewed in what concerns the social group he belongs to; this young male added that the benefits were addressed to the village and forest chiefs, with whom the agreements have been negotiated.

This confusion between chiefs and the community confirms our initial perspective about the hierarchical and authoritarian tendencies from pre-existing traditional political systems, which the indirect colonial rule seems to have accentuated: “(…) colonial refashioning of chieftaincy (…) fused executive, legislative and judicial powers of <customary> authority as the exercise of indirect rule in the countryside”(Woodhouse, Bernstein, & Hulme, 2000). A élite participates in negotiations on behalf of all the community and without any accountability concerns.

Women thus seem to be disfavoured or excluded from processes, since they are not even called for assisting vulgarisation meetings: “women, who could be drivers for positive change are marginalized and under-represented in civil forums(Trefon, 2006, p. 128)”. It is the same with young people. This disables both groups form understanding the processes and perpetuates their dependence towards the male adults and the chiefs.

Once again, indigenous people interviewed in Sapeza had never heard about such a thing as a social clause. One of their representatives in Kinshasa defends his people needs were not take into account in the law making process, although they are the ones who did not have any responsibility in the loss of Congolese forest cover. He adds that this minority needs are not the same as the Bantu people ones and thus they must be considered separately.

There seems to be a huge difficulty regarding this group participation and access to forest benefits, since even when perfectly functioning, the process is designed to valuate the will of the majority and this way indigenous people needs will never be taken into account. There is a need to question the democratic process itself in this sense because, as said by Drydik (2005), development and democracy constitute normative concepts but they should also constitute valid social objectives, otherwise they stop making sense:

> “rules of the game can be reproduced within communities or through consultation limiting the agency and involvement of people without status or confidence (…) culturally defined patterns of interaction go unchallenged and become embedded in social space, effectively silencing certain groups and denying them the possibilities of full participation”(McEwan, 2005, p. 977).

When asked about how they estimate participation processes could be improved, each participant defends a larger involvement of the social group he belongs to. Male adults argue that strong and well-educated man should assume the defence of population’s rights, while women and youngsters opinions’ rather go in the sense of their inclusion in the discussion and decision forums because their activities are impacted by what happens in the forest, thus, they should have a word to say on how it is managed.

Reference was made to financial benefits male adults and chiefs are believed to perceive for their participation in the meetings and that seems to be a complementary reason justifying the interest of people to get involved. On the other hand, those who already are part of the process are not interested in letting go and accordingly defend the maintenance of the *status quo*: “it is clear that patronage and rent-seeking benefits to decision makers play a paramount role in prompting a high degree of central control over wildlife”(Nelson & Agrawal, 2008, p. 563)

Regarding the agreement itself, it is the realisation of infrastructure by the company that seems to be on people’s minds as its definition. None of the interviewed identified communitarian obligations such us protecting the forest from illegal harvesting or denouncing illegal poaching activities as being part of the deal.

It is, though, from the respect of these agreement terms that depends an effective sustainable and participated management of the tropical forest and thus the implementation on a sustainable development programme. The ignorance of the engagements assumed on their behalf and especially the unknowing of their existence totally compromises the agreement’s execution in the spirit of its elaboration. If the State considers itself owner of the forest and the industrial companies consider being their legitimate tenants, local communities in their turn consider the forest is their property under ancestral tradition and customary law. In this perspective it is difficult for them to understand why they need to respect engagements related to forest harvesting: letting a company work in the forest is their part in the agreement and they believe they should be compensated for it.

This relates to the identified negative impacts from forest harvesting, which are essentially the loss of fruit and caterpillar trees and the disappearance of hunting preys, frightened by the machines noise. These concerns are justified because these are essential elements of the community's daily diet. Local communities and indigenous people continue speaking about hunting and farming activities in the forest as well as about fuel wood and charcoal production as part of their daily lives and as part of the forest life. The State is absent and environmental NGOs too: "(…) the power of local conceptions of development conflicts sharply with the <new> discourse of rainforest conservation, promoted (…) by international NGOs, donor agencies and the World Bank" (Sharpe, 1998, p. 28).

With the exception of one of the interviewed, people do not seem to be concerned by eventual negative impacts of forest harvesting besides from those that diminish their capacity for satisfying their subsistence needs; they seem rather worried about the company's capacity to build infrastructures, create jobs and assure transportation of goods and people. These are the needs they identify as their own and subsequently those they try to see satisfied. As defended by Briggs (2005), it would be of great interest for development policies and programmes to understand the problem before trying to design and disseminate a solution.

4. Conclusions

DRC possesses an extraordinarily rich and multivalued rainforest. Managing this huge patrimony sustainably is easier said than done, especially in a context of huge logistical difficulties, where financial, technical, material and human resources are manifestly insufficient.

The intention of implementing sustainable development principles to forest activities has been traduced in the Congolese law by the Forest Code, which promotes the participation of different actors at all different levels in the decision processes.

However, this desired participation model is yet far from being effective in the forest world. By interviewing local community members, indigenous people and their representatives, we came to realize that women and young people are under-represented or excluded from discussion and decision meetings, that Congolese pygmies have yet a long way to run until their constitutional rights and the international principles in their regard produce real effects on the forests they inhabit and that the country's insufficiencies make the implementation of the law an extremely difficult process.

This situation seems to be leading each person to believe firstly in the protection and defence of his own rights, and in maintaining or improving his social group capacity to influence decisions. Each stakeholder seems to be searching how he can benefit from forest harvesting from a community perspective regarding infrastructure building and from an individual perspective, regarding eventual financial profit.

Forest people do not yet have a sufficiently strong voice to be heard amongst others actors' ones in the definition of policies regarding the Congolese forest. However, they are the only ones who effectively live in the forest and the most empowered to manage it on a daily bases, no matter how silenced they are in the laws and regulation making processes. The incapacity of the State to effectively assure control of the immense Congolese territory and the rent-seeking and power desire of some allied to the absence of a real vulgarisation and participation policy which effectively takes into account the forest people needs and aspirations seems to be leaving the majestic Congolese rainforest to its own devices, and its conservation project in huge difficulties.

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Analyzing Barriers and Pathways to Climate Adaptation in Ethiopia: A Research Proposal to Integrate Perspectives from Social, Political, and Ecological Sciences

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Abstract

Both the Intergovernmental Panel on Climate Change (IPCC) fifth assessment report in 2014 and the 21st Conference of the Parties in Paris (COP 21) in 2015 recognized the negative effects of rising seas, severe droughts, and changing weather patterns on global societies, economies, and environments. Indeed, both the IPCC report and the COP 21 agreement provide solid global scale predictions and policies on climate change adaptation. However, it is still unclear what are the best options for individual nations, cities, and communities to protect themselves and prepare for the future climate. Searching for the most suitable options is particularly pressing for the world's developing and vulnerable populations. In Ethiopia, there is a need for economic development to meet the fiscal and social needs within the country. This is compounded with the fact that Ethiopia must also plan for a changing climate that may exacerbate environmental and social issues in the region (i.e. the Horn of Africa). Indeed, current rapid urbanization and economic development in Ethiopia already put a strain on their natural ecosystems and may, in some instances, be at odds with environmental protection. Thus, Ethiopia must address both short and long-term challenges of climate change adaptation by creating a plan for economic development that increases health, prosperity, and well-being of their human and natural systems.

In addition, climate adaptation is still an emerging area of inquiry, with many unknowns existing that concern the planning and implementation of climate adaptation strategies among various communities, organizations, and stakeholders (Shi et al. 2016). Importantly, research has pointed to the adaptation strategies that specifically target climate change impacts on agricultural and urban development. Therefore, in order to understand how best to prepare for the impacts of a changing climate, more must be known about the identification of environmental problems, environmental impact assessments, and the overall inclusion of ecosystem services in both urban and rural locations. Our research consequently presents a unique opportunity to understand climate adaptation from a stakeholder and policy oriented perspective within Ethiopia to answer the overarching question: what are the barriers and pathways for Ethiopia to adapt to a changing climate while proactively promoting economic development? We propose to gather a qualitative bottom-up understanding of climate adaptation planning within a developing country, particularly from the perspective of policy makers, nongovernmental organizations, and other stakeholders from academia and the private sector. Our exploratory research will provide a view of emerging perspectives, problems, and potential pathways to adaptation from the view of Ethiopian policy makers and stakeholders to best fit the needs of this emerging economy.

Roadmap plan for establishing a multinational African Space Agency to improve global environmental sustainability

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Abstract

The importance of Space technology supporting environmental sustainability was recognised in the Brundtland Report, published in 1987. Through the exploitation of satellite imagery, applications have been developed for pollution monitoring, meteorology, desertification and deforestation reduction, agriculture support, climate change assessment and natural disaster mitigation. Earth Observation applications, combining satellite images with ground data have proven to contribute to sustainable environment, in more than one dimension. This has been the case since the 1960s, when the first Space sensors were deployed, now managed by special purpose institutions, like the European Space Agency, National Aeronautics and Space Administration, and others in the northern hemisphere. The CBERS Earth-Resources Satellites was the outcome of a partnership between China and Brazil. Africa as a whole is a few steps behind mastering application of Space technology to improve environmental sustainability, facing pressing challenges to which Space can foster solutions. Nevertheless, nine African countries have been making progress in this field and have Space agencies or similar types of Space institutions and resources. Egypt started Africa's Space era in 1971 and currently operates its own remote sensing Earth Observation satellite. Nigeria's National Space Research and Development Agency launched a satellite for early warning of environmental disaster, control desertification and assist demographic planning. The Algerian Space Agency operated the Alsat-1 satellite, part of the Disaster Monitoring Constellation. South Africa managed to build and operate a satellite with local capacity. The National Space Agency, established in 2010, is mostly acquiring Space data from third parties and through international cooperation. In general terms, Africa's Space reality is characterised by few resources, intermittent programmes, excessive focus on national notoriety, and insufficient exploitation of data by the community. All these factors hinder the achievement of potential benefits. As far as Space is concerned, international cooperation within the African continent is quite scarce, consisting mostly of bilateral agreements between the most advanced African countries. There is no overarching body coordinating Space initiatives in African countries, nor a formal common Space policy. This research focuses on finding out the best approach to model and implement an African Space Agency, that could positively contribute to a more sustainable environment in that continent, addressing its specific needs. The research's initial phase was the exhaustive analysis of all Space endeavours applicable to environmental sustainability. Success cases exist in Europe and North America, where mature institutions are decades old. Emerging nations in Asia and South America were also analysed. The current state of African Space programmes, their key success factors, from past to future, were understood. The African overall environmental sustainability needs, inside the scope of Space technology, are the final piece of the context analysis. From that point, a first roadmap plan for an African Space Agency is formulated, addressing policy, governance model, organisational structure and outline of environmental sustainability applications. Africa's environmental sustainability can be vastly improved via the use of Space Technology with a proper governing body overseeing how the societies' environmental needs translate into mission implementation, and value is fed back to stakeholders.

Keywords: environment, sustainability, Africa, Space Agency, space technology, roadmap

Understanding of Socio-Technical Transition Pressures, Determinants and Blocking Mechanisms: Empirical Perspectives on Community Renewable Energy in Off-Grid Rural Electrification in Nigeria

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Abstract

Nigeria is determined to make an energy transition from a centralised fossil dominated powered system to a community scale energy system powered by renewable energy sources in meeting the energy needs of its vast population that reside in off-grid rural areas. The transformation process envisaged for such a shift is not only complex but also shrouded with a high degree of uncertainty. This uncertainty arises because the transformation of an energy system is not only influenced and affected by technology but also by several other pressures, determinants and blocking mechanisms that operate at different levels and structures of the socio-technical system. Understanding the sources of these pressures, determinants and blocking mechanisms is important for devising a new strategy for an effective transition from one system to another. It is against this background that this study has aimed to develop a more constructive framing of the pressures and determinants as well the blocking mechanisms that are influencing the transition to community renewable energy in electrifying off-grid rural communities through the lenses of transition theory and frameworks. The explorative research adopted a case study strategy and evaluated stakeholders' opinions on the relevant pressures and determinants as well as the blocking mechanisms that are influencing community renewable energy developments. Data was primarily gathered by interviewing relevant key actors in the Nigerian electricity industry. Findings reveal rural area electrification is being influenced by the following socio-economic determinants: lack of energy accessibility in off-grid rural areas; removing carbon emissions at local level; meeting environmental obligations; and, achieving energy security. In addition, the results show that transition to community renewable energy is also being determined by cracks from the current system of rural electrification by means of: the inadequate capacity of the current grid system to satisfy ever increasing demand; the economic cost of extending the transmission grid; and, the unreliable nature of the current grid system. Finally, the thematic analysis undertaken revealed that the transition to community renewable energy is being threatened by several blocking mechanisms that were classified as: actor interaction; institutional; infrastructural; and, socio-political unrest.

Keywords: Socio-technical, Blocking mechanisms, Transition, Pressures, Determinants

The Potentials of Pan-African Research Communities to Cooperate for Sustainable Development

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Abstract

The South-South Cooperation was initiated in 1978 by the United Nations Development Programme (UNDP) and is represented in the United Nation Office for South-South Cooperation (UNOSSC) as a framework for collaboration among countries of the South in the political, economic, social, cultural, environmental and technical domains. In the shadow of general development issues grew the modern world. National Research and Education Networks (NREN) have been established and started linking universities and research institutions at national level, Pan-African level and world wide. The groundbreaking step came with the installation of high speed internet, which enables universities access to virtual resources of research institutions around the world. Previously, landlocked countries have become islands, which could not participate in international research activities, except they had cooperation with a high speed internet provider in neighboring countries. Island solutions grew to a Pan-African solution. NRENs from the different countries grouped together and formed networks and alliances to bundle their efficiencies and opportunities in terms of infrastructure. For example, the Ethiopian Education and Research Network (EthERNet) entered into the alliance with UbuntuNet (regional Research and Education Networking organization for Eastern and Southern Africa) together with other East- and South-African countries and the Pan-European GEANT network (the Pan-European backbone network that interconnects all NRENs across Europe). This allows students, researchers and academics from both continents to collaborate with their peers all over the world. In line with the connectivity, Ethiopian universities have silently become attractive partners for the international research community. The infrastructural framework is set to bring Ethiopia into the league of research nations. But where are the customers? Marketing strategies for the use of EthERNet services are needed to raise potential customers' (students, lecturers and researchers) awareness at the national and international level. Potential customers have to realize that the access to the global world of science and research is just a click away. The aim of this research is to find out, how far universities recognize their possibilities to join international research consortiums or to initiate home grown research by themselves on one side and on the other side to become an international education provider based on e-learning and blended classes in cooperation with Pan-African partner universities. The sample size based on the 32 Ethiopian public universities. Questionnaires are distributed to be completed by the information technology experts and the university quality assessment managers from the 32 Ethiopian universities and present the database for further evaluation. The findings of this survey will be used as the input for the Focus-Group-Discussion within the Consortium of the Ethiopian Public Universities. The compiled findings will be further processed to a recommendation for policy measures for the Ethiopian Ministry of Education.

Keywords: National Research and Education Network (NREN), research consortium, infrastructural framework, Pan-Africa, policy measures

How African Design Perspectives Challenge Sustainable Development

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Abstract

When the World Commission on Environment and Development presented their seminal 1987 report, “Our Common Future”, they sought to address the conflicts between environment and development goals by formulating a definition that highlighted that: Sustainable development is development which meets the needs of the present without compromising the ability of future generations to meet their own needs (WCED, 1987). In the extensive discussion and use of the concept since then, there has generally been a recognition of three aspects of sustainable development: The environmental, the social and the economical. Arguably this diversification of the concept has not only made it cumbersome to use but also diverted the focus from the conflicts and tensions it initially tried to address. The tension between environment and development are expressed and reinforced by tensions between, for example; today and future, we and them, local and global, poor and rich, nature and culture, new and old, rural and urban, sparse and dense, etcetera. Arguably these gaps have profound implications on the kinds of obstacles the transformation from a ‘Development as we know it’ towards a more long term ‘Sustainable Development’ experiences. The tensions and conflicts inherent in the notion of sustainable development provide a lens with which to look at fast growing cities in Africa such as Nairobi with a population in excess of three million. Nairobi, the capital of Kenya, may be perceived as a "New World" given its rapid urbanization and population growth. It is a city faced with the challenge of housing its residents many of whom moved from rural areas that are experiencing poor agricultural prospects in the wake of Climate Change. They arrived in the city with aspirations for a better Quality of Life role-modeled on a consumption driven Standard of Living which the wealthier part of the world enjoys. While slums have historically developed in the city to cope with the enormous need for affordable shelter, a more recent occurrence has been the rapid transformation of the city’s historically low density residential neighbourhoods into higher density residential habitats to meet the pressing housing demand. The need for a viable residential habitat in a rapidly transforming urban context challenges the notion of what sustainability can and should be in a particularly African context: What is the appropriate model for sustainable development in a dynamic urban context? The paper discusses the role design perspectives and locally appropriate strategies play in fostering new role-models for sustainable development. Through cases and review of current strategies employed in a rapidly transforming residential neighbourhood in Nairobi, the authors question business as usual approaches of today and instead suggest a number of more radical alternatives. Their findings suggest the benefits of design perspectives informed by the local context, in better encountering the challenges.

Keywords: Sustainable Development, Residential Habitat, Design perspectives, Climate Change, Local Strategies.

1. Introduction

In 2014, the United Nations Department of Economic and Social Affairs, Population Division, estimated that the global population would have reached 7.4 billion by mid-2016. (UNPD, 2014). In 1950, the global population was 2.5 billion. At the time the Brundtland report was released in 1987, global population had doubled from the 1950 mark to 5 billion. Today’s figure represents a 50 percent increase in just about 30 years. By the year 2050, a little over 30 years from now, the global population is expected to reach 9.5 billion if the current growth trajectory holds. That is an additional 2 billion people, which is approximately equivalent to the combined current populations of India, the United States, Indonesia, and Brazil; which, along which China at the top, account for the five most populous countries in the world (Geohive, 2016).

In Africa, the population growth has been even more dramatic resulting in a total population of 1.1 billion in 2015. This is best exemplified by the population growth in the most populous African country, Nigeria. In 1950, Nigeria's population was 37.8 million. By 1980, the population had almost doubled to 73.6 million. In 2016, Nigeria is the most populous country in Africa and the seventh most populous country in the world with a population of 185.6 million, having more than doubled its population in a span of a little over 30 years. Kenya's population increase mirrors the dramatic trajectories across most African countries. With a population of 6 million in 1950, its population almost tripled to 16.2 million by 1980. Now, with a population of 46.9 million, having nearly tripled its population in a little over 30 years and ranking it seventh in Africa and 29th in the world, Kenya's population is expected to grow to 95.5 million by 2050, representing slightly more than double its current population.

The portrait painted above is one of a world whose population is expanding exponentially in each subsequent generation. It is a situation that portends a lot of challenges for sustainable development. Most commentators would agree that the rapid expansion of global population is quickly approaching the limits of what can be sustained by the earth's limited resources. Optimistic estimates suggest that 9 to 10 billion is the maximum carrying capacity of planet earth based on food production limits and availability of freshwater (Wolchover, 2011). However, more conservative estimates – without fossil fuel to assist agriculture – suggest that "the total carrying capacity of the earth is thought to be somewhat less than the [at the time] current 6.8 billion" (Martenson, 2011:27). A middle of the road value is provided by Sachs (2008) who suggests striving for a stabilised population target of 8 billion by 2050. Nevertheless, the situation is made even more dire given the predominant economic model on which the world runs. A model that measures successful development monetarily in terms of per capita incomes without due regard to whether or not this has been attained to the detriment of the much neglected environmental and social components of sustainable development. Add to this the phenomenon of Climate Change, which alters permanently what was feasible previously in terms of food production and habitats, and you have a situation that requires a reassessment of how development is currently approached. We no longer have the luxury of focussing on "development as we know it" as only being economic. The "sustainable" element has to be brought back into the picture with the re-insertion of the environmental and social dimensions as essential co-dependent ingredients.

It is against this backdrop, that this paper seeks to engage in a discussion of the issues that sustainable development engenders. It does this by anchoring the discussion on the residential transformations, triggered no less by population pressure, occurring in Nairobi, a fast growing city located in East Africa, the fastest growing region on the continent. It is a discussion that primarily looks at the market driven transformations in *Kileleshwa*, one of the suburban residential areas of the city; a testament to the vagaries of an economic development oriented, market-driven, model of transformation.

Nairobi is the capital city of Kenya, a country now considered a lower middle income economy (AfDB, 2015). The city covers an area of 695.1 square kilometres (KNBS, 2015). Its population at the last national census in 2009, was 3.1 million (KNBS, 2010). It is now estimated at 4 million (World Bank, 2014). The city was established more than a century ago by the British, when Kenya was its colony. It started out, in a swampy location, as a railway depot for the Kenya-Uganda railway in 1899 (Obudho, 1997) and has grown since then to become a bustling metropolitan city of about 4 million inhabitants. It is the only major city in the world with a game reserve within its precincts (Patinkin, 2013). The city is also considered the gateway to East Africa given its status as a transportation hub and is home to a number of multi-national institutions including the headquarters of the United Nations Human Settlements Programme (UNCHS/UNHABITAT). It has also recently become Africa's tech hub, and branded the nickname "Silicon Savannah" (Bright, 2015; Bradford, 2014).

Nairobi's residential pattern can be traced back to its colonial roots when the residential areas were segregated along racial grounds (Obudho, 1997). The western higher grounds of the city were demarcated for the Europeans; the eastern portion of the city, adjacent to the railway depot in close proximity to the Central Business District (CBD), was reserved for Indian labourers who were brought in by the British to assist in building the railway line; while the southern area of the city was reserved for Africans whose access to the city was restricted until Kenya gained independence in 1963 (ibid). In the post-independence era, the racial segregation was primarily superseded by economic segregation. The western suburbs of the city became the exclusive enclave of the affluent citizens, the Indian class maintained their presence in the north-eastern suburbs of the city and the low-income citizens found their abode in the low-income areas in the east of the city and in the slums, with *Kibera*, located in the south, as the largest slum in the city (ibid).

The above pattern of settlement has held sway since independence. However, the slums in the city have expanded in tandem with the increase in the city's population and now account for 60 percent of Nairobi's population but occupy only 5 percent of the available residential area (Matrix Development Consultants, 1993). Kenya's population is currently 47 million (WPR, 2016) and its urban population, since independence, has grown to account for one quarter of the country's population, with Nairobi making up a quarter of the urban share (figure 1). Affluent residential areas have not been spared the transformation wrought by the population pressure and economic development. With an expanding middle class (Shah and Ruparel, 2016), a high demand has grown for housing close to the Central Business District (CBD). This has resulted in affluent areas such as *Kileleshwa*, a western suburb only 4 kilometres west of the periphery of the CBD, experiencing rapid transformation in their housing. As of the last census conducted in 2009, *Kileleshwa* had a total population of 16,802 with a total of 4,592 households, and covered an area of 5.2 square kilometres with a population density of 3,210 per square kilometre (KNBS, 2010). In *Kileleshwa*, the market-driven transformation has dramatically led to the conversion of low-density low-rise single-dwelling housing units to high-density high-rise multiple-dwelling housing units in the form of apartment blocks. The rapidity with which the transformations have occurred, only since the beginning of the new millennium, has resulted in outcomes that raise important questions regarding sustainable development. Are these transformations viable in the long run? Are there opportunities for the developments to occur sustainably? Is it even an option not to develop sustainably? What is the appropriate model for sustainable development in a dynamic urban context? What role can design perspectives and locally appropriate strategies play in fostering new role-models for sustainable development in an African context? What strategies are being employed in rapidly transforming residential neighbourhoods in Nairobi? How different can this transformation be if a sustainable approach plays a central role? These are the questions and the issues that the paper grapples with in discussing what sustainable development ought to be in a peculiarly African context with its particular characteristics, opportunites and challenges.

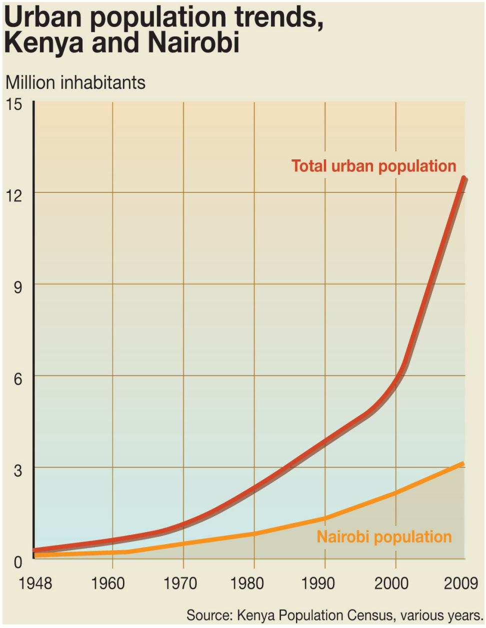

Figure 1. The rising trend of Nairobi's share of the total urban population of Kenya, 1948 – 2009. *Source: Riccardo Pravettoni, UNEP/GRID-Arendal, 2011*

2. Methods

A mixed methods approach was used for the investigation. This comprised of a case study of a rapidly transforming residential area located in the western suburbs of the city of Nairobi. It included visits to the site to make direct observations of the physical transformation of the neighbourhood as well as photographic documentation of pertinent aspects of the transformation including the new apartments that are a physical indication of the evolved urban residential context. A review of literature and documents related to Nairobi's population, economy, environment and housing situation – as well as current strategies employed - was also conducted to augment the empirical observations.

3. Results and Discussion

The discussion below is underpinned by a re-orientation of the perspective of sustainable development as contemplated within the African context. Considered from the current narrative on globalisation, economic growth seems to be the prevailing framework for development. On the other hand, sustainability as understood from the Brundtland report (WCED, 1987) is perceived to consist of the environment, the social and the economy in a more balanced relationship. However, we suggest that the more accurate picture is of the economy as a mere subset of the social and the social in turn as a subset of the ecological or environmental. Arguably, planet earth provides the broad context in which human societies dwell, and there can be no economic activity without human activity. The hierarchical structure seems to reveal itself, by the single fact that the "natural" environment, per se, needs neither social nor economic "pillars" to prosper. On the contrary, it seems very likely that nature should do much better, left alone without the economic growth we as a society try to achieve.

3.1. Tensions of sustainable development

Nairobi is a city that is not only struggling with the challenges concerning both sustainability and development, but also with the combination of the two, i.e. a sustainable development that is not easily achieved by merely adding typical features from the two concepts it consists of. This is made manifest in the various tensions between environment and development evident in tensions between today and future, local and global, culture and modernisation. These various tensions have presented a number of obstacles for a shift from "development as we know it" to long term "sustainable development" experiences. A number of these tensions are discussed below – through various perspectives – as a lens via which to consider the challenge of sustainable development in the city. Nairobi's *Kileleshwa* residential neighbourhood is used as the specific site from which specific cases and illustrative phenomenon are drawn. These tensions as well as the overarching tension between development and sustainability are discussed below.

3.1.1. Tensions between today and future.

The tensions between today and future are made apparent by the transformations that Nairobi is dealing with, which have significant ramifications for the future of the city. The source of the tensions becomes clear when one considers the urban transitions that Nairobi and other African cities are undergoing. A UNCHS report – *The state of African cities 2014: Re-imagining sustainable urban transitions* (UN-HABITAT, 2014) – discusses several transitions that the African continent is going through: demographic, economic, technology and infrastructure, urban, sustainability, and political. The demographic transition draws attention to the high population growth rate. The economic transition highlights the rise of the African middle class – 355 million or 34 percent of the continent's population. The technology and infrastructure transition centres on the emergent need for investment in this sector. The urban transition highlights the high urbanisation rates and growth of primate cites on the continent. The sustainability transition underscores the need for the fast growth to be accompanied by the adoption of greener technologies. The political transition brings to the fore the emergence of democratic states on the continent. (UN-HABITAT, 2014). In discussing the challenges and issues wrought by the transitions, the thrust of the report is that the global North urban model may not be fully appropriate for the continent, and that there is a need to re-imagine African urbanism (ibid).

Nairobi, as the capital and primate city of Kenya, is grappling with the transitions featured in the UN Habitat report. The city's population has expanded dramatically over the last half century. It has seen a rise of its middle class with their high disposable incomes and conspicuous consumption modelled on "western" values. The city has also experienced a high investment in urban infrastructure and uptake of mobile technology, and the rapid expansion of the city has in recent times been accompanied with an increase in the democratic space nationally and decentralisation of government conferring on the city greater autonomy in governance issues as a newly created county government. In the wake of these ongoing transitions the city faces the challenge of shifting from how it was developing to how it ought to be developing. Its future prospects are tied in with the opportunity for the city to embrace sustainable strategies, economically, socially and environmentally, if it is to successfully handle the multifarious transitions that it is undergoing.

The tension between today and future becomes even clearer in looking at the issue of housing in the city. Densification of the residential areas is becoming the pattern for the future. Nairobi, like most cities in sub-Saharan Africa has a high incidence of informal housing. This has been the case for many years since Kenya attained independence. However, in recent years the government, in collaboration with the United Nations, has attempted to address the challenge of low income housing by upgrading the slums – for example through the Kenya Slum Upgrading Programme (KENSUP) (UN-HABITAT, 2007) – through the development of high rise apartment units for the low income residents. However, the project is being undertaken at a scale that would be insufficient to accommodate all the slum residents. On the other hand, on the back of steady economic growth of more than 5 percent per year (AfDB, 2015) and an expanding middle class (Shah and Ruparel, 2016), the city has also experienced a property boom in the areas of the city that have typically been subject to enforced formal planning. This is most evident in the affluent suburban residential areas to the west of the city. A case in point is the *Kileleshwa* residential neighbourhood that was historically the domain of the affluent living in low-rise single-unit single-family residential units. Over the past decade, this residential area has undergone a dramatic shift in its housing typology. The transformation has resulted in the conversion of horizontal low-rise low-density single-unit dwellings to vertically oriented high-rise high-density multi-unit apartment blocks that surpass the zoning height limit of four floors stipulated for the neighbourhood (figure 3). With the transformation, the previously sparsely occupied residential area is fast becoming a landscape of high density apartment blocks with the rental units in high demand from the rising middle class residents (figure 2). Old housing is thus making way for new housing and imposing pressure on the environmental sustainability of the urban context.

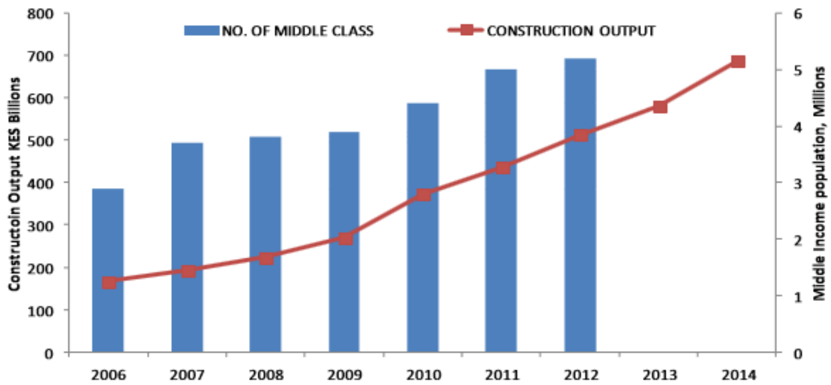

Figure 2. The rise in the middle class in Kenya in the new millennium. *Source: Shah and Ruparel, 2016.*

Figure 3. New high-rise multi-unit apartment blocks in *Kileleshwa*, Nairobi. Source: author, 2015.

The old housing units, primarily bungalows, currently being replaced by the new housing units, mostly high-rise apartments, were noteworthy for their kitchen gardens supplementing the food budget in a healthy way. The practice of farming is something that the earlier generation of residents moving into the city after independence in 1963 were familiar with since an agricultural lifestyle was the norm for the majority of indigenous Kenyans in the colonial era. It was therefore a short leap to naturally integrate kitchen gardens as part of the use of the plentiful space on the half to three-quarter of an acre plots on which the houses in the neighbourhood were sited. These properties were also known for the prevalence of trees resulting in the branding of the area as the "leafy green" suburb of Nairobi. However, the moniker is fast losing its meaning as the trees are gradually felled to make way for the new apartment developments (figure 4). Thus, with the loss of the vegetation, and in combination with the increased built up area, the environmental quality of the neighbourhood is further degraded leading to such negative externalities as excessive flooding due to increased surface run-off during the rainy season.

Figure 4. *Kileleshwa* area 2002 and 2015 depicting a decline in tree coverage with new development.
Source: compiled by author from google images, 2016.

Figure 5. *Kileleshwa* roads flooded during rainfall in May, 2015.
Source: Top Speed Kenya, 2015.

3.1.2. Tensions between local and global.

The tension between local and global can be viewed from the perspective of economic growth in which the flows of capital into the city has reached unprecedented levels. In 2014, Nairobi was ranked as the most expensive city to live in in Africa (Mugambi, 2014). Bradford (2014), classifies Nairobi amongst four other cities, Accra, Cairo, Casablanca and Lagos, as an emerging city and on the international radar. He bases his classification on 12 factors that he sees as important for the growth of the commercial real estate industry: 1) Sustained economic growth at 5% or more. Kenya's economic growth is estimated at 6% or more; 2) Favourable demographics with a fast growing working-age population [70% of population under 30]; 3) Rapid urbanization with Africa urbanizing more rapidly than any other region [city-based population expanding by 3.5% per year]; 4) Expanding urban middle classes with growing discretionary income and the most rapid growth in the middle class occurring in Nairobi along with Lagos, Abuja, Luanda, and Accra hence attracting international retailers, developers and investors; 5) Commodities and energy resources pointing to the recent discoveries of oil in Kenya in addition to other countries in East Africa that will make the region a major exporter; 6) Innovation and technology with Nairobi emerging as Africa's

Silicon Savannah; a regional powerhouse in mobile technology; 7) Increasing Foreign Direct Investment (FDI) noting a 41% increase in FDI into sub-Saharan Africa since 2007; 8) Service sector growth with Nairobi due to its mobile banking platform with a 70% adult population uptake, along with Lagos and Casablanca emerging as regional banking hubs; 9) Offshore jobs opportunity with countries such as Kenya and Ghana developing technology parks to make themselves more attractive for such opportunities; 10) Improving governance, economic management and transparency with improving property markets in Kenya and Ghana which are also seen as suitable hubs for reaching East and West African production and consumer markets; 11) New infrastructure and new [satellite] cities with Chinese funding for railways in Kenya, the development of new satellite cities at the edge of major cities such as the Konza techno city outside Nairobi; and 12) Rapidly evolving commercial real estate market (Bradford, 2014). In addition, Nairobi along with Dar es Salaam, Lusaka, Lagos and Accra made up the top five list of CNN's Africa's Cities of Opportunity based on strongest indicators for investment with the following criteria: GDP growth, ease of doing business, attracting FDI, middle class and overall population growth (Page, 2015).

These foregoing indicators of economic growth while positive from an economic point of view are not a reflection of sustainable development. The middle class is expanding but income inequality still persists and a higher proportion of the city's residents still live informally and in poverty (UN, 2016). The return on investment has become a driving force, privileging the economic over all other considerations. This is evident in the statistics of housing prices over the past decade (Hassconsult, 2016) showing the raid appreciation in property value that in turn facilitates the flows of capital into the real estate market.

3.1.3. Tensions between culture and modernisation.

The tension between the local culture and modernisation is evident in the residential transformation from bungalow type housing to apartment type living. While the market-driven changes in housing type are a positive indication of flows of investment capital into the residential area and the overall economy at large, the rapidity with which it is occurring is not without a series of problems. The most glaringly apparent one is the seemingly haphazard and unregulated manner in which the transformation is occurring. The residential area in question is known to have a height limit of four floors. But apartments exceeding this limit by more than double the stipulation are a common feature (figure 6). Some are glaringly out of scale in relation to the residential context. Other negative externalities, made apparent from a site reconnaissance, include: the indiscriminate chopping down of trees (figure 4) to make room for the apartment blocks – green spaces and trees that were part of the half to three-quarter acre plots for the previous low-rise dwelling units have had to make way for the large foot-print apartment blocks and increased paved surface area leading to a rise in water runoff from rainfall resulting in extreme flooding (figure 5); open communal spaces and playgrounds are virtually absent in the residential area with children resorting to playing on the hard surface, paved driveways within apartment blocks or crowding in insufficiently sized playing yards within the apartment blocks.

Figure 6. A high-rise multi-unit apartment block exceeding zonal height limit of 4 floors in *Kileleshwa*. *Source: author, 2015*

Looking at the design typology of the apartments one would be forgiven for imagining that the development was occurring in a residential area in the global North and not in the global South. However, the mistake would not be too far from the truth. For the reality is that the apartment developments are a good representation of the more neo-liberal profit-driven "western-oriented" approach to development that the city seems to have accepted in its approach to formal residential development – seemingly evaluated positively in the narrow terms of the economic lens of sustainable development given the heavy capital flows into the developments. The developments are primarily market or developer led with a keen concern for a maximum return on investment on each individual development site at the likely expense of the overall neighbourhood. Since the different apartments are independently initiated and developed by a variety of developers, little attention is given to overall coordination of the projects to assure a sustainable neighbourhood considered from a more holistic perspective that incorporates not only the economic but the social, environmental and cultural facets as well. The city's local government, with authority over development control, appears to have adopted a laissez-faire attitude in allowing all manner of apartments to spring up in this residential area without due regard to height-limit, design quality, open space, cultural and social appropriateness, and overall environmental and urban sustainability of the neighbourhood (figure 6).

Figure 7. Questionable quality of new apartments under development. *Source: author, 2015.*

The apartment designs are a direct importation of foreign concepts of what the building form ought to be and do not borrow from the local African context in which they are situated. They are generic in design orientation and lack a specific local identity – whether in material use, finish, or colour – that could contextualize them. A great deal of attention has been paid to "western values" assumed to be the aspirational values of the newly emergent middle class residents moving into the area. A telling example of this is a banner advertising an upcoming apartment development in the neighbourhood that has as its key promotional image a pictorial urban scene from London complete with a London bus. Moreover, the apartments being developed are promoted for their novelty, which is equated with being modern due to their use of exotic materials. Hence, there is a deliberate effort to ignore the local context and the materials readily available locally with a heavy focus on imported materials. An example would be the roofing tiles; little attempt had been made to recycle the tiles that were used on the bungalows, which the apartments are replacing. These tended to be beige in colour, appear locally made, and merged naturally with their foliage dominated context. Now, the upcoming apartments stand out from their context with their bright roofing tiles that make no attempt to acknowledge their foliage-dominated historical context but rather emphasize their uniqueness, which is further reinforced by the seeming competition to have a one-of-a-kind building form. This is resulting in generic buildings in the sense that they could be transported to any city in the global North and fit right in. Additionally, the importance of communal, socially shared space is ignored in favour of more individualized space. The latter being good for independent "modern" living but unhelpful as far as a sense of culturally-oriented community life is concerned. This situation is evident given the absence of public open space. Even within the apartment developments there is insufficient open space and play area for the children – They are forced to play in the road and driveways thus exposing them to the hazards of vehicular traffic and potential injury from the hard surfaces.

3.1.4. Tension between development and sustainability.

Part of the tension that exists between development and sustainability has to do with what sustainability amounts to when combined with development. The two terms are debatably perceived to be polar opposites or at best challenging to reconcile. When the terms are coupled as sustainable development they have been defined in various ways. For example, beyond the definition offered by the Brundtand Report (WCED, 1987), Jeffrey Sachs considers sustainable development to essentially mean, "prosperity that is globally shared and environmentally sustainable" (Sachs, 2008:31). In this definition, development, consistent with most perceptions, is arguably articulated in economic terms.

Contrastingly, however, tension exists between the diverse views held in regards to the definition of sustainability. There is a lack of consensus on what it specifically entails. The literature on sustainability is inconsistent in how to define or evaluate sustainability. For instance, there are positions that perceive sustainability as being too narrow a perspective hence insufficient as the panacea for all urban ills. In this vein, Inam (2014) proposes that within the urban context urban transformation should be the objective rather than a singular objective such as sustainability. Some scholars have suggested possible features of sustainability: Unsworth (2015:329) discusses what she refers to as "dimensions of a sustainable neighbourhood." In this, she references Rudlin and Falk (1999) as having "set out principles of developing sustainable neighbourhoods for the long term." Thus she states:

> Places that accommodate households and economic activities according to thorough sustainability criteria have physical structures designed to last longer, to be as inexpensive as possible to acquire, run and maintain, while also being carbon neutral or negative and in every way exhibiting high environmental performance. Connectivity and accessibility, supporting services and cultural opportunities, green infrastructure and accommodation for productive activities have to be provided in far sighted ways to attract a wide range of residents and satisfy their needs sufficiently to keep them there. (ibid)

Ancell and Thompson (2008) discuss an alternative form of sustainability, in relation to housing, which they refer to as social sustainability. They suggest that this form of sustainability can be analyzed using notions of social equity and social justice. Taking a broader perspective, Burton, Jenks, and Williams (2003) consider various notions of what a compact city in relation to sustainable development may mean highlighting the different ways in which the compactness of a city especially in relation to residential areas has been conceived thus showing that a universal standard has yet to be established. On the other hand, Dalgliesh, Bowen, and Hill (1997), though focussing specifically on affordable housing provision in South Africa, bring to the fore the environmental sustainability of housing. They argue that despite new building procurement systems indicating an increasing awareness of sustainability, the concentration is on economic and social sustainability, as opposed to environmental sustainability. They go further to elaborate on a range of relevant principles for sustainable construction, which they suggest incorporates: minimisation of resource use; maximisation of reuse of resources; maximisation of use of renewable and recycled resources; use of non-toxic materials; protection of nature; achievement of quality criteria; and promotion of labour intensive methods, skills training and capacity enhancement of local people. In a comprehensive analysis, drawing extensively from sustainable development and environmental planning literature, Jabareen (2006) identifies sustainable urban forms and their design concepts. His analysis identifies seven design concepts related to sustainable urban forms: compactness, sustainable transport, density, mixed land uses, diversity, passive solar design, and greening. Moreover, he identifies four types of sustainable urban forms: the neo-traditional development, the urban containment, the compact city, and the eco-city.

The vastly different perspectives on sustainability indicate the relative distances that the various approaches have in relation to ecological sustainability, which approximates a more holistic understanding of the complex and multifaceted aspects and dimensions that make up sustainability. Perhaps the ideal of sustainability is still best captured in the definition of sustainable development given in the Brundtland Report by the World Commission on Environment and Development (WCED); “development that meets the needs of the present without compromising the ability of future generations to meet their own needs” (WCED, 1987). In the non-specificity of this definition, there exists some room for sustainable development to be tailor made to specific contexts while adhering to fundamental principles.

3.2. An Alternative Approach

With a more holistic approach to sustainable development, a plethora of opportunities exist for how the future development of the residential neighbourhood can be shaped. Some bear elaboration: If attention is paid to the social importance of community, shared responsibility, and informal social networks in the African context, more attention could be paid to the development of substantial communally shared spaces within not only the apartment complexes but within the neighbourhood as a whole. This could range from open spaces to playgrounds to community gardens. The latter could also double up as a source of fresh vegetables for the households within the neighbourhood. If due consideration is given to the indigenous culturally influenced aesthetic values, the design of the new apartment blocks could reflect African design values, evident in traditional architecture and artefacts, in their composition, morphology and finish. While the precise materials used in the construction of the apartment dwellings may not necessarily be the same as those used in traditional architecture due to issues such as durability and fire safety, the forms of the structures, both exterior and interior, could echo the traditional design orientations in aspects such as pattern, texture, colour, and finish. In such manner, some traditional materials, appropriately finished, could very well find a use in the new developments. Additionally, imported building materials, which are substantially used in the new apartment buildings, could be minimised if, instead, locally available materials were sourced thus reducing to the greatest extent possible the ecological foot print of the building construction. If acknowledgement is made of the absence of high rise dwelling experience in traditional built form, especially in sub-Saharan Africa, greater care could be taken in enforcing a reasonable height limit that pays attention to the human scale, and avoids the minimisation of social networks that is typically the outcome of high-rise apartment structures.

3.3. An African Design Perspective

Design, understood from the broader view of imagining and planning for a desired future scenario or outcome, coupled with the particular African context, offers a perspective that challenges the notion of the global South unquestioningly ascribing to the value laden “western-oriented” perspectives of sustainable development, especially where economic growth is seemingly equated to sustainable development (WCED, 1987). An example of an unquestioning acceptance of the less broad view is Kenya’s Vision 2030 in which the country’s vision for prosperity is articulated principally in terms of attaining the economic status of becoming a middle-income economy by the year 2030 (GoK, 2016).

Thus, speculatively, an African design perspective is one that privileges the African context with its inherent cultural, aesthetic, and social values and couples this with viable sustainable design strategies to promote a more holistic approach to sustainable development that is best suited to specific local situations in the global South. In another sense, an African design perspective is one that borrows from the principles of its traditionally established ways of designing. To take the example of the traditional hut which is the most prevalent form of housing in the rural context, one can derive some immediate principles. The dwellings are inspired by nature and therefore organic in form. The materials from which the huts are made are a clear demonstration of the use of locally available resources and therefore the process of construction results in a smaller ecological footprint. To illustrate, readily available thatch is used as a roofing material and twigs are used for the skeletal structure of the hut while a mixture of clay and mud is used to infill the structure. Even cow dung finds a use as a final finish material to smooth the floors and walls. These structural and roofing materials are easily obtained close to rivers that are a critical water source for traditional settlements hence are easily replenished when needed. It is a principle that is characteristic of informal settlements which are typically built from discarded easily available materials such as plastic, tin cans and cardboard boxes thus demonstrating a proclivity and resourcefulness of being able to make use of locally and readily available resources and in this case a natural inclination to creatively recycle what would typically be regarded as waste and thereby of little use. Moreover, there exists a rich resource of literature, such as texts by Denyer (1978) and Elleh (1996) that documents, in detail, the history, geography and evolution of African traditional design, architecture and practices, which can be drawn on as sources of relevant knowledge.

Hence, an African design perspective is, at its heart, essentially about the appropriate orientation. It is about being locally appropriate and taking cognisance of cultural, social, aesthetic, and other indigenous resources and incorporating them in development approaches, in this case, residential housing, to ensure that the outcome is sustainable development understood from the broader more holistic perspective of including the tripartite dimensions of the economic, the social, and the environmental – held in their proper hierarchical relationship. Thus, plans adopted for the development of housing in the city would align better with sustainable development if evaluated in relation to their appropriateness to the local context.

4. Conclusions

Several conclusions can be drawn from the preceding discussion:

Sustainable development is a concept that is replete with tensions that make it a challenge to pursue. What is evident however, is that it also affords an opportunity to address issues that are particular to a specific local context. In the preceding discussion the context contemplated has been the African one with the transformations in a specific residential neighbourhood in a city located in East Africa used as a case through which to examine the various tensions that sustainable development portends.

It has been highlighted that some important tensions that have to be grappled with include those between today and future, local and global, culture and modernisation, and, overall, between development and sustainability.

The tensions between today and tomorrow are essentially a result of urban transitions and the resultant pressure on the environment. The tensions between local and global are the result of the pressure of the especially globally driven economic growth mantra. The tensions between culture and modernisation are the consequence of pressures to adopt an alternative cultural orientation and value system in contradistinction to the traditionally inherited one. And the overarching tension between development and sustainability is principally the result of a lack of consensus as to what sustainability should specifically entail especially given the various local contexts in which it is supposed to be effected.

The foregoing tensions represent a clash between contrasting values; locally and culturally rooted ones with those that arrive on the wings of global economic development. It can be concluded that the path to addressing these tensions begins with first privileging the environmental aspect of sustainable development in combination with locally specific and relevant approaches that can be said to be anchored in an African design perspective that draws its inspiration from the local cultural heritage and traditional practices that align with a perception of sustainability that prioritises the environment.

It can also be concluded that the market-oriented rapid transformations occurring in the case study neighbourhood may need to be reshaped to align better with the local context and a re-oriented approach to sustainable development that considers the economical dimension as a subset of the social and the social as a subset of the environmental. It is recommended that sustainable development needs to be specifically evaluated in relation to the particular context in which it is being considered. It cannot be generalised but needs to be configured to achieve “sustainability” in a locally valid way.

Sustainable development, especially its environmental and social components, need to be foregrounded in discussions of sustainable development. Despite the tensions between seemingly polar opposites, the bridging of the gap between the seemingly opposed forces has to be part and parcel of a sustainable approach. In the wake of Climate Change, the environment cost of the business as usual approaches that were the mainstay of urbanisation since the industrial revolution in the 18th and 19th centuries, are far too great to continue unaltered. It is now necessary, despite the obstacles, to move, by addressing the tensions, from “development as we know it” to more long term “sustainable development” experiences.

Design, at the very minimum, affords us the opportunity of imagining the future we want and figuring out the way to get there. A more sustainable future is for the benefit of us all. The radical alternative is arguably the sustainable one. It is a challenging option because it re-directs attention away from the prevailing fossil fuel dependent resource depletion economic development model. However, it is the most desirable path if we are to secure our future conterminously with the future of the planet.

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Figure 1: Riccardo Prevattoni, UNEP/GRID-Arendal, 2011. Urban population trends, Kenya and Nairobi. http://www.grida.no/graphicslib/detail/urban-population-trends-kenya-and-nairobi_10f4# (accessed 12.04.2016)

Figure 2: Shah, S., and Ruparel, R., 2016. The transformation of the Housing Finance Company of Kenya. Centre for Affordable Housing Finance in Africa (CAHF), Johannesburg. p.3. http://housingfinancafrica.org (accessed 03.03.2016).

Figure 3: Photograph of *Kileleshwa* taken by Collins S. Makunda taken in December, 2015.

Figure 4: Compiled by author from google maps of Kileleshwa, Nairobi. https://www.google.no/maps/place/Kileleshwa,+Nairobi,+Kenya/ (accessed 10.12.2016)

Figure 5: Top Speed Kenya, May 12, 2015, Kileleshwa Flooding https://www.facebook.com/permalink.php?story_fbid=2075194402621278&id=156559401151464

Figure 6: Photograph of *Kileleshwa* taken by Collins S. Makunda taken in December, 2015.

Figure 7: Photograph of *Kileleshwa* taken by Collins S. Makunda taken in December, 2015.

Context driven models for private sector engagement in skill building initiatives

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Abstract

There are a number of large challenges in the world today affecting the lives and wellbeing of billions of people globally. One great issue is the growing unemployment, with an estimated 200 million people actively looking for work worldwide. Youth unemployment is particularly acute, especially in Asia and Sub-Saharan Africa. At the same time, the world is rapidly changing and there has been a shift in power balance, where the business and civil society organizations are becoming more influential, at the expense of governments. This is driving corporates to take more responsibility for social impact and nonprofits to become more market like. There is a growing awareness from both practice and academia that successfully solving social issues in this new global landscape requires collaboration between all sectors. Indeed, the benefits of working together across sectors to meet social issues far exceeds those working in silos. In initiatives to solve youth unemployment there are increased demands for the private sector to be engaged to define the market skills needed, as well as to fill the role as employers or buyers of the output and services of entrepreneurs. Cross sector collaboration is an emerging field of study, and the majority of previous research exists within the for-profit and public disciplines. There is a need for more research on business-nonprofit collaborations with a nonprofit focal point. There is also a need to understand the strategic challenges of partnerships. This paper aims to contribute to extant literature by examining the contextual and strategic challenges of cross sector collaboration to build youth skills in Sub-Saharan Africa, with a focus on the nonprofit sector. Using a case study approach, programs run by global child rights organizations to build skills among youth in Uganda, Tanzania, Zambia and Kenya are studied. Main findings conclude that the contextual factors influencing the strategic choices and value generated from collaboration initiatives primarily concern the differences between rural and urban areas. The strength of the corporate sector is found to exceed the expected significance in initiative success. Given the weak corporate sector of the rural areas, building skills within the agriculture sector is the most immediate means of catalyzing economic empowerment and as a result entrepreneurship, in contrast to employability and job placements, is found the most successful intervention. In addition, the potential value generation from the collaboration for the private sector takes longer in rural areas as opposed to urban areas, influencing the nonprofits value proposition for private sector engagement. As a result, further understanding of new and innovative context driven models for private sector engagement is needed. Irrespective of context, it is found that it is both possible and imperative to create a compelling business case based on value generation potential for both business and society to secure private sector engagement.

Key words: Cross sector collaboration, private sector engagement, skill building initiatives, rural and urban context, shared value

Intersectionality and Place: Examining Community-Based Climate Change Adaptation

Elizabeth Edna Wangui

Abstract

From its origins in Black feminist thought, intersectionality has been applied in a variety of disciplines to investigate how multiple and interacting forms of difference engage with power and inequality. Much of this literature examines how the intersections of race, gender, class and other forms of difference intersect to define how individuals engage power. In this paper, I take intersectionality a step further and add 'place' as an important axis of difference that influences how individuals engage with power. Specifically, I look at how gender intersects with wealth status and place to influence adaptation knowledge and practice. The intersectional analysis that I present emphasizes political and structural inequalities that critically impact an individual's or group's adaptive capacity.

I draw on five years of fieldwork in the Kilimanjaro Region of Northern Tanzania. Qualitative data were collected at multiple scales – regional, community, household and individual. The regional dataset was based on a household survey of 950, that provided information on how adaptation opportunities and constraints varied from one place to another within Kilimanjaro Region. At the community level, we carried out assessments of key adaptive practices in three villages. This was followed by household level interviews whose goal was to assess how adoption of adaptive practices varied within each community. Based on the results from the household interviews, key informants were selected and interviewed in order to understand how difference and sameness relates to power in ways that impact climate change adaptation.

Gender and wealth status were critical determinants of who had the knowledge and the assets needed for climate change adaptation in the region. Men, more than women, and wealthy individuals more than the poor were able to mobilize the assets they needed for adaptation. These ranged from physical assets such as water for irrigation and equipment to till the land, to instruction on the use of improved seed varieties. My results further indicate that to fully appreciate how an individual's multiple subjectivities impact their ability to adapt to a changing climate in Tanzania, one must consider the political distance of the individual's geographic location from the seat of power. This paper concludes with a reflection on the applicability of an intersectionality framework that is spatially explicit for climate change adaptation and the broader field of sustainable development.

Coastal ecosystem valuation as a tool for sustainable planning in Maputo

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Abstract

Many of the large urban areas of Africa are located along the coast, as is the case of Accra, Lagos, Luanda, Cape Town and Maputo, placing them both by their colonial origin and by its geographical context in a category of large cities that have a particular and strong relationship with their landscape setting, similar to places such as Mumbai, Rio de Janeiro and Hong Kong. Nature and urbanity are in extremely close proximity, with both spectacular and problematic results (Beja da Costa et al., 2009). In these cities, urban sprawl often occupies structuring and risk prone places of their ecological structures, namely proximity to flood plains and to vulnerable coastlines. Additionally, climate change and sea level rise introduce another dimension to the risk, (Tucci, 2009) that must be considered while planning these cities' coastal areas. Focusing on Maputo, Mozambique, this paper will analyse an African capital that faces many development pressures, and where most development projects are targeting its coastline. This one is formed by both valuable and vulnerable landscapes in terms of visual quality and in terms of the quality of the natural resources and ecosystems value, given the variety of environments such as swamps, dunes and alluvium deposits, (Oliveira et al., 1996) that allow for the existence of a variety of biotopes. In turn, these play important roles for both the territory and the local population, given the value of the environmental setting as a direct food source, as a flood and hazard control mechanism and as a biodiversity asset to the city (which presents further economic gains for the city). This paper firstly presents an overall review regarding Maputo's current urban planning processes; secondly it describes the specific ecological values of Maputo within its broader ecoregion context. The study proposes to analyse the valuation of ecosystem services of Maputo's coastal landscapes, centred on the belief that there are greater benefits in retaining natural habitats than converting them into plantations, shrimp farms, etc. (de Groot, 2005) or into urban areas. It questions if the incorporation of ecosystem services may become a strategy towards the improvement of sustainable planning of the city's coastal areas. The themes of ecosystem values and sustainability are to be addressed regarding a shift in Maputo's urban development paradigm, aiming at safeguarding its natural systems while contributing to maintaining the city's well-known image of quality.

Keywords: Maputo, Coastal Ecosystem services, sustainable urban development

1. Introduction

The world is experiencing the fastest urbanization process in history with a projected 4.9 billion people to live in cities by 2030, corresponding to almost 60% of the world's population (IFOU, 2009). Megacities, defined by the United Nations as a metropolitan area with a total population of more than 10 million people, were firstly found in North America (New York) in the 1950's, secondly in South America (Mexico City) and in Eastern Asia (Tokyo) during the 1970's; from 2000 onwards and with an increasing rate of growth, new megacities rose throughout the world (UN, 2006). The trend continues and more recently these megacities have begun to emerge in Africa - though few urban regions can be considered megacities (Lagos, Cairo) - in what promises to be one of the more remarkable forthcoming developments in the overall pattern of urbanization (UN-Habitat, 2012).

Many of the large urban areas on the African continent are located along the coast, as is the case of Maputo, where urban sprawl often occupies structuring and risk prone areas. Additionally, the near future will bring new challenges for such areas in Maputo, namely infrastructural changes that include the Katembe bridge construction or the new ring road (Maputo, 2008) that will have an impact both on the urban form and the natural ecosystems of the city's coastal area. The estuaries' ecological systems throughout Maputo's coastline are not being taken into account in ongoing and (near) future large-scale urban development projects and the exuberant wealth of Maputo's coastal ecological systems is being consumed both by the fast influx of people into the city and by the large development investments being made in urban projects.

This paper firstly presents an overall review of Maputo's urban planning processes and secondly the specific ecological values of Maputo within its broader ecoregion context are described. A qualitative analysis of the current urban plans for Maputo's coastal area and an analysis of the current state of its ecosystems, through literature review and study of satellite photography, allow for an evaluation of ecosystem values and sustainability regarding a shift in Maputo's urban development paradigm. The analysis equally allows for an evaluation of the current state of ecosystems and investigation of its potential value for the sustainable planning of the study area. This paper is based on the initial fieldwork findings and in the organization process of the secondary data collection for the ongoing PhD research in Landscape Architecture and Urban Ecology entitled "Merging ecological systems and urban infrastructures at Maputo's coastline".

2. Methods

2.1 Specifics of recent urban expansion processes in Maputo Municipality coastline

Maputo is Mozambique's largest and economically most important city, accounting for about 30% of the country's gross domestic product. The surrounding "semi-rural" areas are undergoing a fast process of densification. Maputo and its surrounding metropolitan area, including the administratively separate city of Matola, has a population of over two million. (Promaputo, 2012).

Large investments are being made by the city's administration that through an extensive project sponsored by the World Bank - the Maputo Municipal Development Plan (Promaputo) aimed at leading institutional reform and municipal governance (estimated budget 10.8 million US$), to monitor municipal finance (estimated budget 5.3 million US$), and to improve planning and service delivery (estimated budget 25 million US$). This includes immediate spatial impacts, aiming to improve solid waste collection and management and to improve and increase road infrastructure (Promaputo, 2012).

The 2008 "*Plano de Estrutura Urbana do Município de Maputo*" (PEUMM) (Maputo Municipality Urban Structure Plan), makes a thorough analysis of the city's current situation, with an overview of past and current development and structural plans for the city. This document refers to the city's ecological structure, enumerating five categories for the structure: humid low land areas (mangroves), flood prone areas, green forested protection areas, urban green areas (gardens and parks) and beaches. The PEUMM refers the importance of these categories, solely in a descriptive manner, and the need to regulate construction indexes and protection mechanisms, though it does not refer the tools required for this (Maputo, 2008). It seems that these categories can be a useful starting point to study Maputo's ecological structure, but the articulation between the information within the PEUMM and the reality of Maputo's natural systems seems far from being complete.

Whereas urban development in Maputo was, up to the 1970s, contained on the plateau on the North margin of the Maputo Bay and in the Baixa area, nowadays the city's expansion is moving towards the last vacant stretches of land: the low plane along the Costa do Sol, Marginal and Katembe, in the South margin of the Maputo Bay. These areas are advertised by promotors as the most desirable areas for middle and high income class housing, and as tourism facilities due to its proximity to the sea and beaches, privileged views and a comfortable distance and accessibility to the city centre.

This development is contemplated in the *Planos Parciais de Urbanização* (PPUs - Partial Plans for Urbanization) that derive from the 2008 PEUMM. From North to South these are: the Costa do Sol PPU, the Área Marginal de Maputo PPU, the Baixa de Maputo PPU and the KaTembe Masterplan. Some references to previous plans are still noticeable, such as the 1985 *Plano de Estrutura da Cidade de Maputo* (Maputo City Structure Plan) and the 1999 *Plano de Estrutura da Área Metropolitana de Maputo* (Maputo's Metropolitan Area Structure Plan) (Maputo et al., 2015).

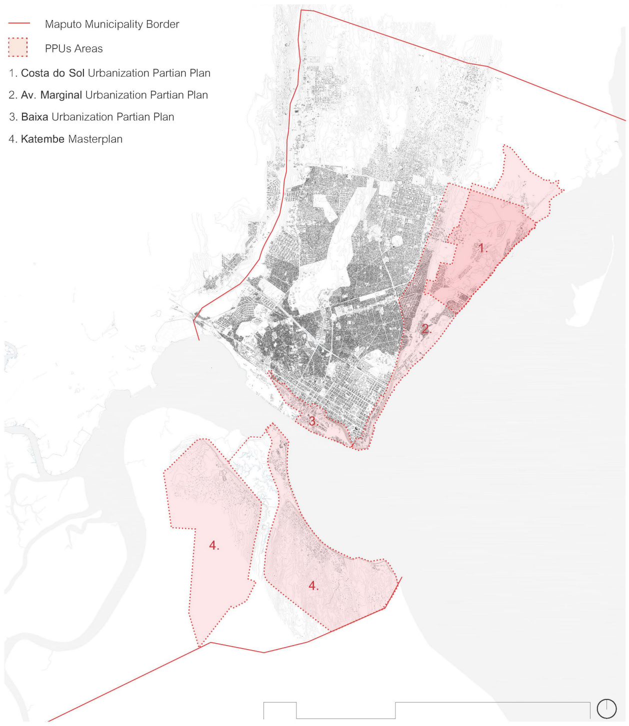

Figure 1. Partial Plans for Urbanization location in Maputo

2.1.1 Costa do Sol Partial Plan for Urbanization

The Bairro Costa do Sol represents in its origin the 1975 fusion of the Bairro KaMavota with Bairro Polana Caniço B. Fishing was the main activity of its inhabitants, that came at that time from the periphery areas of the so called Lourenço Marques. An exception on the occupation of that area was the *Bairro do Triunfo*, a middle income class neighbourhood that was established in the 1960's, filling part of the swamps and "planting the seed" for urban expansion (Lage, 2015). From 1983 onwards, it started receiving emigrants from several areas of the country, due to the intensification of the civil war (DRPUA, 2013b) and at the moment is the target for new investments and large infrastructure projects under the scope of the PEUMM.

Concerning its ecological structure, the PPU acknowledges "arborized landscapes" with dominance of mangrove coverage of 237,70 Ha (in 2013), a low forest area of 261.50 Ha that occurs mostly in the Xefina Grande and Xefina Pequena Islands. Both of these areas are classified in the Plan as "Green Areas for Protection". The main problems identified in the report as to be solved through the implementation of the PPU Costa do Sol are: (i) occupation of ecologically sensitive areas; (ii) spontaneous occupation; (iii) floods and sea intrusion; (iv) occupation of protection areas (mangroves), previously classified as “Areas belonging to the Ecological Structure” and as “Green Area for Protection”; (v) coastal erosion; (vi) lack of accessibility and mobility (DRPUA, 2013b). It is important to note that despite the fact that the ecological structure is quite simplified in the PPU report, most of identified problems are related with this same structure.

Overall, the Costa do Sol urbanization major problems are related to the hydrological system: draining rainwater through the means of drainage open pipes, draining water from the underground water table, reducing erosion, waste water and sanitation. It considers that the “establishment of naturalized or formal water surfaces, especially when adjacent to the roads, is particularly suitable” (DRPUA, 2013a). Again, the acknowledged Mangrove Protection Area, well referenced and established in the plan report, does not show any relation or potential quality, nor a functional relation with the surrounding areas.

2.1.2 *Area Marginal de Maputo* Partial Plan for Urbanization

The *Area Marginal de Maputo* Partial Plan for Urbanization considers the coastline to be a spontaneous area within the city morphology, and acknowledges the quick and often contradictory transformation pressures that it is subject to and that will change the “social and urban order that exists nowadays”. Along with urban high income and low density areas, urban void areas, such as the mangrove, the Golf or the former car race tracks, and middle and low income areas coexist. In the midst of this all, the “original layout of the *Aldeia dos Pescadores* maintains its characteristics and vitality”. (Maputo et al., 2015) This PPU geographically overlaps the PPU Costa do Sol.

The *Area Marginal de Maputo* PPU makes relevant statements in relation to the mangrove area. It considers its need for protection and in addition the need for a connection to the Bay, in order to guarantee the survival and sustainability of this relevant feature of Maputo’s coast. (Maputo et al., 2015) The PPU Report also addresses the sea level rise problematic, acknowledging that there is a need for a disaster prevention and occupation strategies, in order to minimize the loss and waste of means and resources. In this sense, and taking in account that this report is from 2015, this is already an improvement when comparing it with the neighbouring plan reports. The PPU states that tourism and residential are the main vocations of the Marginal of Maputo area due to its unique location and setting, but always giving a strong emphasis on the environmental protection aspect. It recognizes the value of the Avenida Marginal waterfront as a landmark for producing an image of the modern city, and it considers real-estate speculation and informal housing occupation the main and contradictory pressures for this area. The Avenida Marginal PPU reinforces as major guidelines: “Conservation of the environmental factors, enumerated as sand beaches, dunes, riverside vegetation, agriculture areas and mangroves; Housing development: high standards and private sector investment area; Tourism and leisure; Waterfront, as a resource for transformation and improvement of the city” (Maputo et al., 2015).

Concerning the areas directly implied in the crossing of the Avenida Marginal and *Circular de Maputo* ring road – that is transversal to several Partial Plans for Urbanization and that represents one of the major ongoing investments in the area – the PPU considers that these should be valued through the future adequate urban development. It criticizes its proximity to the coastline since it blocks access to the beaches and diminishes the quality of its fruition. The PPU also criticizes the blockage to the mangrove and rainwater drainage that is occurring due to the road construction, whereas one of the priorities of this PPU is to open up water channels and retention basins so that the connection between water systems is improved and the mangrove sustained.

The PPU report reinforces the need for a holistic environmental vision. It states that a harmonization of the environmental aspects should not only be identified in this plan, but also in the adjacent PPU’s (Costa do Sol, Polana Caniço, Baixa,…) and the ones on the West side of the area. The main environmental problems to be considered are soil erosion, rainwater drainage and climatic resilience.

2.1.3 Baixa de Maputo Partial Plan for Urbanization

The Baixa area is the origin of the Maputo settlement as we know it. It is the historical neighbourhood of Maputo and it still has, as in its origin, a major commercial and administrative vocation. It sits on reclaimed marshlands and alluvial deposits that link the area to a stretch of elevated "interior degraded fixed dunes and sand layers" (Oliveira et al., 1996) where the city mainly developed during the 19th and 20th century. This relevant geology has "important enterprises in the city at the Ponta Vermelha. A great many of the geological accidents in the city, such as landslides, erosion and tilted buildings have occurred here."(Maputo, 2008) The Baixa is frequently subject of flood events, namely along the 25 de Setembro Avenue (Conselho Municipal de Maputo, 2014).

Almost fully a formal and consolidated area, corresponding to the "*Cimento*" (concrete) city, it houses commercial and industrial functions and few residential areas. It corresponds to Maputo's CBD where major projects are foreseen. In the introductory stages of the Baixa PPU, the main existing problems referred to, are: traffic and parking congestion, low public transport coverage; lack of infrastructure to support informal commerce; water supply; drainage and sanitation; energy supply; and solid waste collection, treatment and disposal; The absence of maintenance or improvement of these infrastructures – being most of them previous to 1975 - is a concern when considering high density developments, due to stress increase on the existing infrastructure, that can limit (even more) the performance of urban services (Conselho Municipal de Maputo, 2014)

The Baixa PPU is divided into three sectors: *Baixa Central*, *Baixa Este* (East) and *Baixa Oeste* (West).

The "Waterfront Promenade" is the brand of the Baixa PPU. It has about 2.5 km extension, from the *Baixa-Central* section to the *Baixa-Este* section. It envisions a downgrade of motor traffic circulation to a one-way system (West-East) in order to give space for pedestrians and cyclists, to increase the row of planted palm trees for shading area and local commerce and restoration areas. Within the Chapter "Public Space of Private ownership (5.2.2.5)" there is reference to a "waterfront linear square" that aims to increase structural resistance to extreme climate events and sea level rise. It consists on a 10m wide green strip from the built line (towards the sea), where 80% of the surfaces should be permeable. Here, guidelines and bonuses for investors shall be negotiated case by case (Conselho Municipal de Maputo, 2014). It is highly questionable whether a 2.5x0.01km semi-permeable strip can mitigate sea-level rise, when the guidelines for it are negotiated plot by plot.

2.1.4 Katembe Masterplan

The Katembe District General Masterplan was presented in 2012 by the consortium Promontório Planning – Betar, ordered by the *Empresa de Desenvolvimento de Maputo Sul* E.P. This public enterprise was created by the Government of Mozambique "to promote the building and management of the Katembe Bridge, roads from Maputo to Ponta do Ouro (including the Circular de Maputo) (…), as well as connected activities" (Promontório, 2012).

The first phase consists in the construction of a bridge that will improve the accessibility towards Ponta do Ouro; the second phase is the construction of a new city extension dependent on foreign investment, and where a future middleclass will settle. "Maputo South, the new part of the city should host 400.000 inhabitants by 2040. The master plan has already been approved and incorporates housing, commerce, industry, services, tourism and leisure"(Van Orshoven and Ysenbaardt, 2014). It defined 13 operational units, of which 3 have an approved *Plano de Pormenor* (Detailed Plan), and would have different functions according to location, potentialities and accessibility to the projected highway. An approximate area of 3,000 ha is preserved and remains as an agriculture and ecological reserve (Promontório, 2012) according to the initial masterplan, that intends to address the three main environmental problems of the area: flooding, coastal erosion and deforestation. This city extension could represent part of the solution to address the city's main problems, such as traffic and parking congestion, housing supply, electricity and water supply overload, etc. (Bettencourt, 2016)

2.1.5 Transversal to all coastal Partial Plans for Urbanization

The reviewed PPUs are structured according to the traditional comprehensive planning structure tools, inherited from the 20th century colonial and socialist planning influences (Mendes, 1980), and they do not contemplate the current problematics that Maputo, as a coastal city, faces such as the sea level rise and the incorporation of natural systems in the city's green structure in an integrated manner. Its neo-liberalism development results on the one hand in large migration influxes and extensive informally urbanized areas and on the other hand in large investments being made at a city scale, and in private developments sprouting at a plot scale. Biophysical characterization is often incoherent and lacking linkage between morphology, natural processes and landscape valuation. The current planning tools lack updated intellectual backgrounds and are based in a mind-set where coastal wetland areas are not acknowledged dynamic landscape features.

In legal terms, it is important to refer that in Mozambique land is owed by the state, as it is considered "a universal means of creation of wealth and social well-being and its use is a right of the people". Thus, the legal instrument giving rights over the land is the Right to Use and Benefit from the Land (DUAT: *Direito de Uso e Aproveitamento da Terra*), conceded upon request from public or private entities or individuals and it recognizes the rights acquired by inheritance or occupation (when not attributed legally to a third party). It cannot be attributed in Public Domain, nor in total and partial protected areas. Nevertheless special licenses can be issued and the Council of Ministers can "create, modify or extinguish partial and total protection zones" (Moçambique, 2015), thus jeopardizing the integrity of ecological systems.

There is an operative gap between the planning instruments - PPUs (2013-15), the Katembe Masterplan (2010)-, environmental impact studies - the "*Circular de Maputo* ring road environmental impact studies" (2012), the "*Costa de Sol* Swamp and Mangrove Zoning and Protection Study (2010), amongst others (see Figure 2) and the actual projects being implemented. The DUATs add another layer of complexity since they are transversal to all the studies and plans and are subject to political will. A deep change in mind-set is needed to address "adaptation deficits" (Roberts et al., 2011), and to coordinate basic infrastructure works, as upgrade and extension of sewage, rain water drainage and road networks that can work as an integrated system that prioritizes and accommodates water level fluctuations needed for the well-functioning of coastal ecosystems. In turn, these should start being acknowledged as "soft engineering" (Kithiia and Lyth, 2011) assets that can decrease infrastructure costs and increase its resilience.

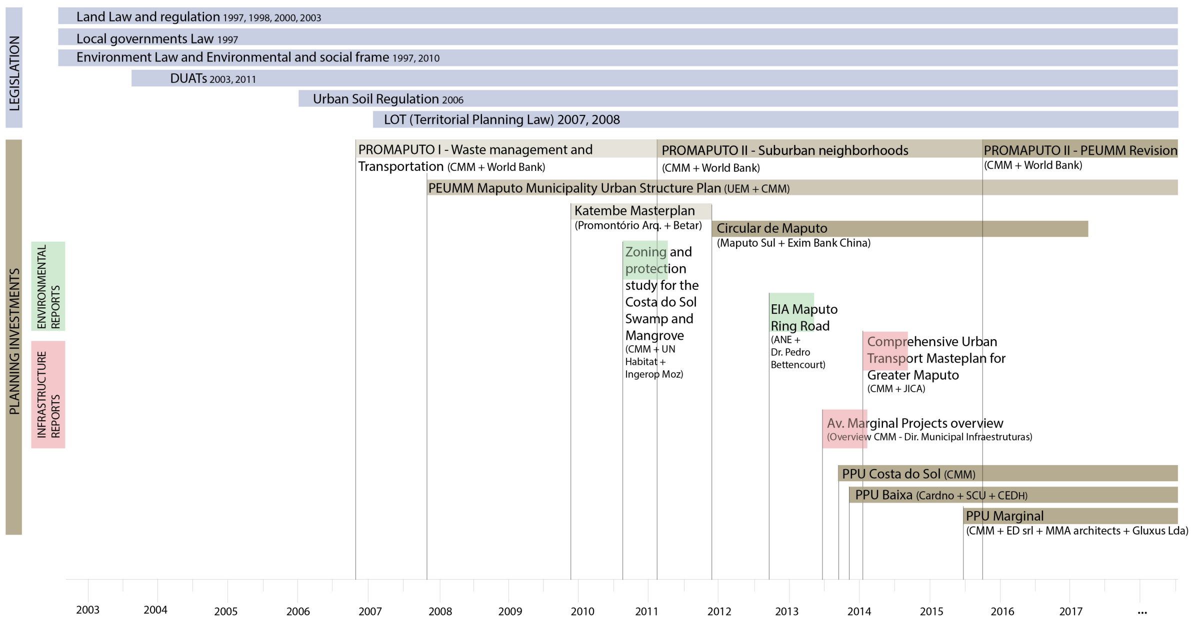

Figure 2. Urban planning legislation and recent urban investments timeline

For example, the main infrastructure artery that is now under construction – the *Circular de Maputo* ring road – considers a 10 to 20 meter buffer area (in the Costa do Sol PPU) with multifunctional services. Parking and accessibility to the beaches are not contemplated in the report, neither the implantation choices for the road trajectory. The ring road cuts through the plan area as it cuts through water circulation outlets, mangroves and through the *Aldeia dos Pescadores*. As stated in the Avenida Marginal PPU, "there is a constant and strong human pressure" in the abovementioned areas, and that "none of the ongoing projects under construction are guided by any Partial Plan or Detailed Urban Plan. The only guiding instrument is the PEUMM" (Maputo et al., 2015). Meanwhile, private investors develop in a "plot-by-plot" process throughout the Av. Marginal, supported by the DUATs. It is possible that the actual building process, mainly coordinated and executed by internationally outsourced firms, influences the planning processes through the disregard of the established plans and a lack of capacity (or interest) to enforce these. Additionally, these international firms also bring their own interests, namely financial ones.

2.2 Specific ecological value of Maputo Municipality coastline

Mozambique's ecoregion is contemplated in the Millennium Ecosystem Assessment Sub-global component of Southern Africa, including Botswana, South Africa, Zambia and Zimbabwe (UNEP, 2005). It is inserted in the Southern / Eastern African sub region. In terms of Mozambique's ecoregions characterization, Mozambique comprises several, and Maputo's region is comprised within the "Maputoland Coastal Forest Mosaic". This consists of 30 303 km² of 'Tropical and Subtropical moist broadleaf forests', described by the World Wild Fund Organization as:

> "Flanking the Indian Ocean, the Maputoland Coastal Forest Mosaic includes a wide variety of habitat types, such as dry forest, swamp forest, grassland, wetland and estuarine systems. As a result, floral and faunal diversity and endemism are high. Nearly 10 percent of vascular plant species found in the ecoregion are endemic, including 3 endemic plant genera. Charismatic species such as the African elephant (*Loxodonta africana*) are also found here, offering a high potential for ecotourism. Almost 14 percent of this ecoregion is contained in protected areas. However,

> invasive exotic plants and expanding populations are starting to place considerable pressure on the natural environment in South Africa. Although Mozambique is still relatively depopulated south of Maputo, there are threats from large-scale deforestation and other forms of development, even in formally designated reserves." (Kirkwood)

The coastline of Maputo flanks the Maputo Bay. It is the confluence of six rivers: the Incomati, at the North edge of Maputo region; the Infulene, that is the Western physical limit of Maputo's municipality; the Matola River, that confines and gives the name to Matola city, the Umbeluzi, the Tembe and finally the Maputo River, at the Southeast tip of the bay confining the Katembe district on the East side; (Beja da Costa, 2014) forming a "large body of water of 1280 Km2 with an average depth of 10m (…). It is strongly influenced by the tide and receives the discharges of three large rivers (Incomati, Umbeluzi, Maputo) and can thus be considered as the lower part of a compound mega-estuary. The inner morphological limits are the mouths of the several single estuaries that discharge into it (Bandeira and Paula, 2014). The study area that this paper reports to, is situated within the administrative border of Maputo Municipality which comprises only part of the Maputo Bay and where the ecosystems played a dominant role in shaping the city's morphology. It is important to mention that we will exclude the ecosystems of Inhaca Island, as these are not included in the aim of the urban-nature interface that this research is focused on.

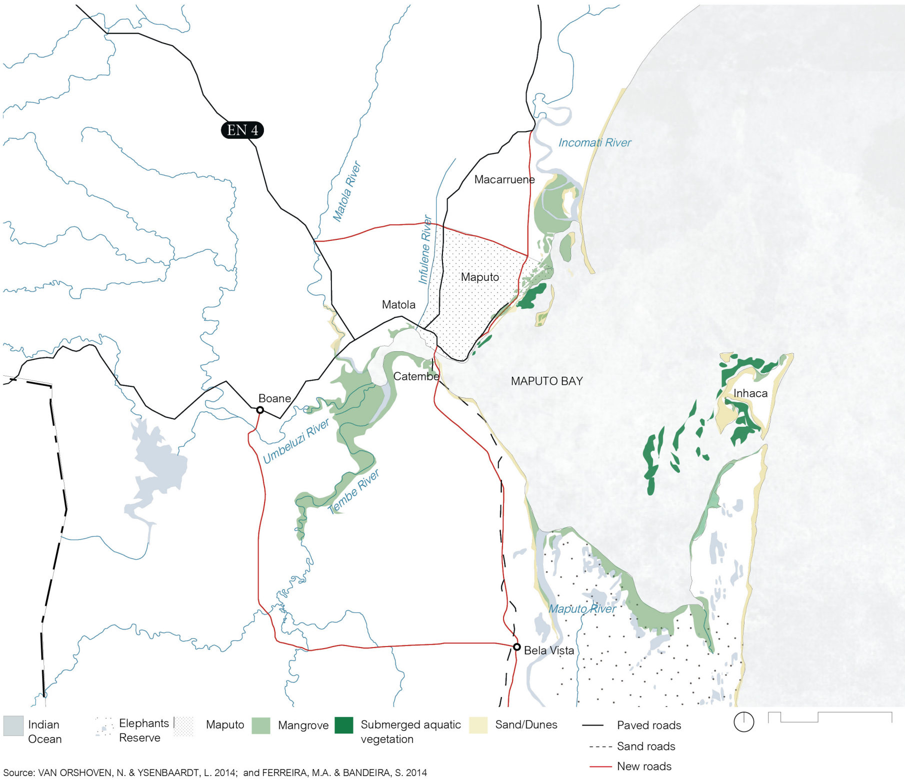

Figure 3. Maputo Bay estuary and its ecosystems

Coastal wetlands, as the ones in Maputo Bay, are among the most productive yet highly threatened systems in the world, framed and protected by the Convention on Wetlands (Ramsar, Iran, 1971), of which Mozambique is a party since 2004. As such, wetlands are the only group of ecosystems to have their own international convention (Turner et al., 1999) and have since been generally defined as "areas of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six meters." In this document, Recommendation 10 is specific on "African Wetlands", enhancing the value of the African wetlands as habitats for migratory waterfowl with wintering season in Africa and recommends the enhancement of "research on productivity of wetlands and, possibly with the help of UNESCO, establish an African List of wetlands of international importance (...)" (IUCN, 1971). Described by Odum (1971) as "high diversity tropical coastal ecosystems", that due to low temperature and salinity changes, can divert their energy to elevated symbiosis degrees, complex life cycles and organisms adaptations, as the mangrove swamps root adaptation to salt water, as organism that due to adaptation to intense luminosity present high levels of organic nutrients, seagrasses meadows and coral reefs, and through this produce disproportionately more services relating to human well-being than most other systems" (MA, 2005). Maputo's coast currently suffers from direct drivers of degradation as: "population growth and increasing economic development, which include infrastructure development, land conversion, water withdrawal, pollution, overharvesting and overexploitation, and the introduction of invasive alien species" (MA, 2005) in such scale that surpasses the ecosystems tolerance limits (Odum, 1971).

2.2.1 Mangroves

In the Municipality of Maputo several relevant wetland ecosystems are identified: starting from the Northern border of the Municipality, in the low lying plane between the *Ponta Vermelha* ridge and the sea, the flood plain of the Incomati River's mouth present a considerable area of mangrove forests, that is being progressively fragmented by urban development; mangroves reoccur in the Southern margin of Maputo's Municipality, on the right margin of the Tembe river (see Figure 3). These considerable mangrove areas play an important role on the functioning of the coastal and marine ecosystems in the Bay. They are a nutrient-rich environment and sheltered nursery ground for marine fauna, they regulate sedimentation, prevent coastal erosion and protect the coastline from storms and high tide events (Bandeira and Paula, 2014), both by diminishing water runoff speed and by sustaining the soil. The mangrove forests along the Maputo city coast also have a relevant role as regulators of water quality and wastewater filtration. Mangroves provide important ecosystem services that go beyond mere water security and water for food security. Other ecosystem services provided by wetlands include nutrient cycling, climate change (mitigation and adaptation), food security (provision of crops and nurseries for fisheries), job security (maintenance of fisheries, soil quality for agriculture) and a range of cultural benefits, including knowledge (scientific and traditional), recreation and tourism, and formation of cultural values, including identity and spiritual values." (ten Brink et al., 2013)

Figure 4. New urban fringes colonization of the mangrove at Costa do Sol (2015)

It is stated by de Boer that the mangroves in the Maputo Municipality have decreased -90% in the Maputo city area, -49% in the Katembe area, -85% in the Costa do Sol and -22% in the Bairro dos Pescadores, between 1958 and 1991 (de Boer, 2002), showing a clear negative evolution in the Western margin of the bay, caused on the one hand by direct use, exploitation urban and infrastructure development. This trend is likely to have continued in a faster pace until the current date.

2.2.2 Sand dunes

Throughout almost all the coastline there are coastal dunes formations. In the North margin, from the *Bairro dos Pescadores* and through the full extension of the Costa do Sol area until the Polana Caniço B area. In the South margin, a sand beach is continuous since the Katembe tip until the mouth of the Maputo River (see Figure 3). These comprise what is classified as dune vegetation mosaics of two types: pioneer dune plant communities, composed mainly by succulent and creepers that stabilize sandy soils, reducing the intensity of erosion from the shoreline up to the consolidated dunes; And by young dune scrub plant communities, in areas of soft topography previously stabilized by pioneer communities (Bandeira et al., 2014b); These occur mostly between the Desportivo Sports Club and the Bairro dos Pescadores, in the North coastline and between Katembe and the Maputo River Mouth, in the Southern coastline of the Maputo Municipality.

2.2.3 Seagrass

Areas of submerged aquatic vegetation, which consists of seagrass vegetation (Ferreira and Bandeira, 2014), are described as critical habitats with multiple essential roles in the shallow-water environment, formed by higher plants that have adapted to live in a marine environment dominated by changing water levels, temperature and salinity (den Hartog and Kuo, 2006 in Bandeira et al., 2014a). They grow in proximity to the mangrove ecosystems, distributed between the Bairro dos Pescadores tip and the Xefina Island, and along the Costa do Sol (see Figure 3). They function as a nursery for fish and crustaceans and contribute to the consolidation of sediments (Paula, 2016), mitigating erosion.

2.2.4 Compromised ecosystems

Many coastal wetlands will change as a consequence of projected sea level rise. The lowest areas of Maputo, which include the harbour and railway infrastructures, can and are likely to flood if no adaptation measures are taken. Other increased potential impacts of climate change are referred to in the Baixa PPU report, such as increased intensity of floods, droughts and cyclones; coastal erosion; contaminated and decreased water resources; increased health problems related to water resources and heat stress (Conselho Municipal de Maputo, 2014).

The Incomati flood plain is under pressure from the ring road construction, as previously described in section 2.1.5 of this paper. It crosses straight through what was already considered “sensitive landscape” in the Regional Masterplan for Maputo’s city planning of 1969, in an extension of about 20 km. An embankment prevents the road from flooding. (Van Orshoven and Ysenbaardt, 2014) The consequent division of the landscape will block tidal movements into the plain, compromising the fragile ecosystems that lie within. Mangrove swamps are decreasing. The large areas of small horticultural and agricultural plots will not have natural access to water; and the fishermen living in the *Bairro dos Pescadores* will lose direct proximity to their income source, the sea. On the other hand, once the road has formed a barrier between the coastline and the city and diminished water influence on the low plane, the trend of this area to become Maputo’s next (dangerously) urbanized territory will be drastically enhanced.

Bairro dos Pescadores 2000 Bairro dos Pescadores 2016

Figure 5. Ring road construction and progressive landfill and occupation of the Incomati floodplane at Bairro dos Pescadores (years 2000 and 2016 comparison)

The same is happening in Katembe, where the bridge pillars and highway axis are sitting on wetlands. We can expect a similar process to happen, cutting water circulation, constraining Katembe people's access to natural water courses and agricultural and grazing areas. The bridge construction project and the Katembe Masterplan foresees an immense population increase on this relatively slow moving, low density area. Also, the relocation from the (informal) *Bairro de Malanga*, in Maputo to Katembe can bring pressures: its population, if relocated, will lose easy access to Maputo centre, as the bridge does not contemplate pedestrian circulation (Forjaz, 2015). As such, it is possible that these people will not be able to maintain their original income sources and it is likely that they will put additional pressure on Katembe's surrounding ecosystems.

Katembe 2001 Katembe 2016

Figure 6. Bridge construction yard at Katembe in proximity with mangroves and floodplain (years 2001 and 2016 comparison)

Finally, the sand dunes on this coastline are now very reduced on the Northern shore of the study area, as they are being built upon from the Ponta Vermelha until the Bairro dos Pescadores. In Katembe they are still present along the beach.

3. Results and Discussion: Ecosystem services valuation as tool (or strategy) towards sustainable planning for Maputo's coastline

There is an awareness that Maputo is currently facing a key moment of its urban development, "one that will shape the city for generations to come" (Conselho Municipal de Maputo, 2014). The exhaustive Partial Plans for Urbanization mention the will of the Concelho Municipal de Maputo to engage the city's inhabitants, stakeholders and public and private entities in processes needed to improve Maputo's living conditions, and to keep up with the tradition and ambition of being a model city within the African geographical context. What is questionable at this point is the operability, articulation and coherence between plans, planning tools and implementation processes, and the lack of integration of the city as a whole in relation to the natural processes that it interferes with. Furthermore, the management of investments are one of the key factors in the implementation of priority interventions at the local scale, that need to be articulated within the city's regional scale, taking into account the natural and environmental factors that work beyond the city's boundaries.

A leap forward towards a sustainable Maputo is to consider the ecosystem services concept as a basis for the ongoing complex planning processes, integrating the plans' spatial analysis, stakeholders and decision making entities. "The most important contribution of the recognition of ecosystem services is that it reframes the relationship between humans and the rest of nature" (Constanza et al., 2014), putting natural resources in perspective of economic valuation, not only production wise but also through its "enhanced value", related to the position in the landscape (in-land, riparian, coastal wetland..), corresponding functions (sediment retention, waterfowl, storm buffer…) (Mitsch and Gosselink, 2000) and possible trade-offs.

The valuation of ecosystems is a useful tool to measure the intrinsic value of ecosystems and its translation into economic terms, which can be applied in the case of Maputo's ecological systems. Ecosystem services – namely food, freshwater, energy, fibre; diseases control; global climate; protection from natural disasters; non material benefits to people (UNEP, 2005) - were acknowledged at the Eight Conference of the Parties to the CBD (2006), as "overwhelming contributors to human life and well-being" (UNCBD, 2006). These services are provided by multi-functional landscapes, often referred to as "natural capital". The notion that wetland ecosystems can become an essential asset to the planning processes of the new urbanized areas of Maputo, can become evident by acknowledging that:

Mangroves can be used as indicators of sea-level rise (de Boer, 2002), but also as storm and tidal surges mitigating element, and consequent changes in river flow regimes and sediment transport (MA, 2005) and for erosion protection. That these can act as resilient storm buffers that mitigate and adapt to climate change and as such, decrease costs of infrastructural works, as the protection wall built at Costa do Sol, shifting the construction trend from "hard engineering works" to "soft engineering solutions" (Kithiia and Lyth, 2011).

Figure 7. Mangrove destruction for the ring road construction;

flood retention wall at Bairro dos Pescadores (2015)

Urban coastal ecosystems in Maputo should be regarded as service providers of goods for consumption, as food sources and in providing fuel and material for boat and housing construction, as it still happens in the original settlements of the coastline, as Bairro dos Pescadores and Katembe, meeting people's basic needs and improving their quality of life (Roberts et al., 2011); and as service providers, for example as waste treatment by recycling waste components (Cilliers et al., 2013), among others.

Also the cultural and religious meaning of mangroves and wetlands to local population should be considered as these areas are often used by the local population for religious ceremonies. At the Costa do Sol beach and at the mangroves near Bairro dos Pescadores, groups gather for prayer on the mangroves on a weekly basis. They also gather on the beach, for resting and socializing at the end of the working day. This should be preserved and enhanced as 'cultural ecosystems services', commonly defined as the "non-material benefits people obtain from ecosystems through spiritual enrichment, cognitive development, recreation, and aesthetic experience" (Plieninger et al., 2015) are relevant in changing perspectives in the way planning processes should be carried out, as "the individuals who benefit most from the conservation of wetlands are often residents, including many who are likely to have been disenfranchised from decision making processes. Decisions concerning the fate of wetlands, however, are often made through processes that are unsympathetic to local needs"(MA, 2005,p.7). In this sense, fieldwork done (and to be continued) in the scope of the PhD research has major relevance, in identifying the relation of local communities with the surrounding landscape, in understanding local management of ecosystems, in defining what are the current trade-offs for these communities and identifying factors of degradation.

Finally, the middle and high income class urban areas, where basic needs of the population are taken care of, wetlands and coastal dunes have potential for becoming the new public spaces, for their aesthetic and for more functional attributes (Mitsch and Gosselink, 2000), incorporating short-term recreation functions, providing human health and psychological well-being for its users (Plieninger et al., 2015). Mangroves, beaches and (few) sand dunes at Costa do Sol and Katembe represent an incomparable landscape and visual asset, associated with the sea view in the city, altogether increasing real estate value and tourism potential, and consequently increasing their own ecosystem value.

Economic valuation of the services provided by the abovementioned ecosystems, many of which are already being engulfed by urbanization, can bring to light the implicit value of the existing ecosystems, assessing "critical thresholds" for their functionality (Mitsch and Gosselink, 2000) and eventually enhancing the need for its conservation and integration in the planning processes at multiple scales, considering it an urban multi-functional landscape. It is relevant to remember that "many services delivered by wetlands (such as flood mitigation, climate regulation, groundwater recharge, and prevention of erosion) are not marketed and accrue to society at large at local and global scales and that (…) individuals often do not have incentives to maintain the services for the benefits of wider society. (…) In some cases, the benefits of conversion exceed those of maintaining the wetland, such as in prime agricultural areas or in the borders of growing urban areas. However, as more and more wetlands are lost, the relative value of the conservation of the remaining wetlands increases (…)."(MA, 2005), reinforcing the 'economic law of scarcity' – the rarer the more valuable.

4. Conclusions

As far as current urban planning in Maputo is concerned, legal and operational tools that are put into practice nowadays, at city and neighbourhood scales, describe the importance of preserving ecological features as elements rather than as systems. The PPU´s do not inhibit numerous real estate developments and infrastructure works to sprout wildly. In combination with increased demographics and consequent urban sprawl, the urban planning practice still jeopardizes the integrity and conservation of Maputo's coastal ecosystems.

Ecosystem services valuation is an operational tool that presents a possibility for a shift in the urban planning paradigm in Maputo, from a neo-liberalism development perspective towards a sustainability perspective. Through applying ecosystem valuation methods as a starting point for urban planning; by researching in concrete terms the functions and figures associated with the existing ecosystems and their specific trade-offs, the planning proposals can become more informed on how to integrate ecosystems in their outputs and through that, they can add value to urban development and quality of life in the city. Acknowledging that “wetland value appears to be maximum when distributed spatially across a landscape that is not dominated either by cities or agriculture, but one that balances nature and human enterprises” (Mitsch and Gosselink, 2000). Further research is needed on how this can be realized in a context where formal planning processes are mostly guided towards resisting nature, rather than to live with.

In practical terms, local communities are the ones that have most knowledge about the value of the coastal ecosystems with which they coexist. As such, an important step towards the shift in Maputo’s planning strategy is to raise awareness amongst local communities so that they can be empowered to stand up and preserve the natural capital of their city, instead of losing ground to real estate development (which is not going to necessarily improve their own housing conditions). A conjugation of a precise economic valuation of the coastal ecosystems, together with the bottom up change of attitudes towards planning decisions should be tested, to improve usage and integration of these landscapes in the African urban reality.

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Building Landscape Resistance in the Horn of Africa

Maria Ivanova, J. Michael Denney, Paul Case, and Alexander Metzger

Abstract

Land and water resources in the arid and semi-arid parts of the Horn of Africa have come increasingly under pressure as a result of different drivers of change. Climate change, population growth, land use change, encroachment of invasive plant species, over-extraction of water for irrigation and water pollution are important trends that adversely influence the resilience of the Horn's ecosystems and those that dwell within them. 40% of the population in the Horn is chronically undernourished, and many more are food-insecure. The vast majority of the Horn's population relies on traditional rain-fed agricultural and livestock rearing practices that are extremely vulnerable to climate change. If the region is to continue to sustain its current economic growth and poverty alleviation, it will have to become more resilient in terms of its environment, livelihoods, agricultural systems, and institutions. International development projects have long attempted to address these issues by building capacity, improving infrastructure, investing in communities, and technology transfers.

At best, these projects have mixed long-term results, and at worst they are blamed for sub-Saharan Africa's persistent under-development. This paper uses data from resilience workshops and semi-structured interviews in the Horn of Africa to present the current challenges to the region's resilience, highlight best practices already being employed, and investigate the failures and successes of the region's development projects. The workshops and interviews were conducted over 6 months in three different landscapes: Laikipia in Kenya, the Central Rift Valley in Ethiopia, and Djibouti. The workshops and the individual interviews surrounding the workshops included local stakeholders from all levels of society including community representatives, business leaders, policy-makers, international organization professionals, government employees, and others. Overall, through review of the literature, workshop discussion and interviews, and examination of failed projects, we determine that development projects should be designed with a clear focus on multistakeholder involvement and participatory design and implementation.

Keywords: multistakeholder, international development, Horn of Africa, agriculture, resilience

Exploring synergies between climate and electrification goals – the cases of Ethiopia, Kenya and the Democratic Republic of Congo (DRC)

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Abstract

Partners to the UNFCCC have been asked to make their pledges and contribute to climate change mitigation through Intended Nationally Determined Contributions (INDCs). Funds have been allocated to support developing countries implement climate mitigation and adaptation measures. Meanwhile, the global sustainable development agenda has also been approved, including energy and climate goals. In other words, we would expect that INDCs explore the synergies between climate and development agendas. In 2012, Ethiopia, Kenya and the Democratic Republic of Congo (DRC) had electrification levels of 26.6%, 23% and 18% respectively. This also means the three countries had populations of 70 million, 35 million and 60 million with no access to electricity. The electricity access targets of Ethiopia, Kenya and the DRC for 2030 are 75%. The objective of this paper is to analyze how these countries improve energy access in a context of climate change mitigation. The analysis explores (i) the electricity mix aimed for, (ii) the expected GHG emissions from electricity generation until 2030, and (iii) electrification and related metrics. Ultimately, we aim at a better understanding of what these countries' climate and development strategies encompass in terms of emissions reductions as well as electrification goals, as per reflected in their INDCs. Given the bottom-up process inherent in the INDCs and the climate agreement mechanism, the paper gives insights on how these countries have used the INDCs to prioritize sustainable electricity access. The electrification goals are achieved by increasing generation in these countries for domestic use and enabling access to generated electricity. The INDCs are an ideal platform to achieve this if generation capacity is increased by catalyzing climate finance if the expansion falls under the category of climate-appropriate technologies. The BAU case electricity generation has been computed using a simple regression model. It has been compared with targets given by the countries or multilateral organizations. The regression model's independent variable is the GDP/capita for each individual country. These GDP/capita forecasts are also an underpinning assumption of their submitted INDCs, and thus it is reasonable to use them in the regression model to forecast electricity generation. The diversity of the power mix is calculated using the Shannon-Weiner Index. The percentage of renewable energy sources are calculated along with their share in the total potential available in each country. The results show that the three countries have different storylines as to their sustainable electricity access targets and their INDCs. Ethiopia aims at nearly 100% renewables for power in 2030, while Kenya's renewables only generate 54% of the total electricity provided in 2030. In the case of DRC, the renewables are very high, but the per capita electricity use is very low and it will become a power exporter. Although the climate mitigation goals for the energy sector as defined in the INDCs of the three countries are ambitious, they still have a long way to go in translating the electricity access ambitions into feasible domestic electricity use.

Keywords: electricity access, INDCs, GHG emissions, sub-Saharan Africa, renewables

Special track posters

Preliminary inventory of the energy use in the rural areas of Angola

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Abstract

In Angola, only 30% of the population has access to electricity, although Angola has extensive hydroelectric power resources that far exceed its present needs and crude oil production in Angola ranks second in sub-Saharan Africa. Improving access to affordable energy is critical to improving living standards in countries like Angola, and especially in the rural communities. Therefore, an energy consumption survey was conducted in the province of Huíla, in Angola, to have a better understanding of the energy demand and to help designing effective intervention strategies for the rural energy sector of this province of Angola. Huíla has an area of 79,023 square kilometres and a population of 2,354,398. It is divided into fourteen municipalities, having 39 towns (comunas) and Lubango is the capital of the province. The geographical coverage of the survey varied from rural to urban areas, ranging from a single village to a cluster of villages, and to the large urban centers, such as Lubango, with a population of 1,414,115 and a population density of 450 people per square kilometres. The survey was planned to provide information on the average urban and rural energy consumption for cooking, water heating, lighting and space heating, the resources used, and the devices used. Along with the energy survey, an assessment of biomass resources potential for bioenergy production was also performed. Preliminary results indicate that biomass represents the major energy source, contributing to 65% of the province's primary energy supply and that 50% of the population rely on biomass for most of their energy needs, especially in rural areas where the number reach 80% of the population. However, the direct combustion of biomass, in the rural areas, in traditional devices is sub optimal from a technical, environmental and societal perspective. The use of traditional forms of energy – firewood, charcoal and agricultural residues – on the fulfillment of their basic energy needs, is associated with the use of low efficient cookstoves that carry adverse effects, such as emissions of particulate matter that are harmful to health, deforestation and environmental degradation. The data base still needs to be strengthened but with this background it can be looked as a base for energy planning, meeting the challenges and opportunities for the sustainable production of energy in this province of Angola.

Keywords: rural development; energy planning; sustainability; energy policies

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Carbon dioxide emissions in Portuguese fisheries: trends and future perspectives

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Abstract

There is a growing worldwide concern about greenhouse gas (GHG) emissions and several targets have been set, with implications in a wide variety of economic sectors. Fisheries and their emissions have been paid less attention compared to other means of transport (e.g. road transport, aircrafts) and economic sectors (namely agriculture). We have analysed data on the evolution of the Portuguese fishing fleet over the recent years and evaluated carbon dioxide emissions per fleet component. The analyses performed also addressed the carbon footprint of the most commercially important fisheries resources. Although the fishing fleet has been decreasing in number, the majority of vessels that ceased their activity were small, with a low contribution in terms of emissions. Furthermore, since some of the most targeted species have decreased their abundance, the carbon footprint of the main resources tend to increase. The adequacy of several measures in order to reduce carbon dioxide emissions of the fishery fleet are pointed out and the impacts of their implementation discussed.

Towards sustainable sewage systems: Integrated socio-technical and socio-ecological assessment

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Abstract

Sewage disposal systems constitute complex systems providing the essential societal functions of ensuring public sanitation and hygiene as well as protecting water resources. The success in fulfilling these functions depends strongly on the flexibility of the system to adapt to changing conditions such as technological developments, demographic changes, local capacities available, or environmental impacts. The author proposes that in order to be successful (i.e. providing effective, efficient, and sustainable sewage disposal systems and related services) governance processes in the sanitation sector have to take into account both – socio-ecological and socio-technical aspects. So far, these domains have been analysed separately. The research presented here, therefore, aims at adapting and extending existing frameworks for the integrated analysis of socio-ecological-technical systems (SETS). As a first step, patterns of sustainable system architecture need to be identified: *Which technological and resource properties, policies, and socioeconomic processes have an impact on the effectiveness and sustainability of socio-ecological-technical systems (SETS) such as sewage disposal systems? What are the central elements characteristic for sustainable SETS from a system- and decision-theoretical perspective? Which relations and feedbacks on the same as well as across system and spatial levels shape sustainable SETS? How do the social, ecological, and technological spheres co-evolve against the backdrop of their situational socio-economic and institutional embeddedness?* The identified patterns and relations will provide a generalization and extension of the analytical framework used. Furthermore, the effects of changing framework conditions are being taken into consideration. The analysis of general patterns includes the objective to identify typical enabling or limiting factors towards a smooth transformation process, where changes in the governance system support new technologies, and where at the same time new technologies meet the requirements and needs of the population. This means that the emergence, dispersion preconditions and impacts of technological infrastructure developments are analysed. The final result of this currently on-going work is an extended and dynamic framework able to cover all aspects (social, technological, ecological) of sewage disposal systems in municipal settings. With this framework an instrument for a better understanding of successful governance in the field of municipal infrastructure shall be provided. Nevertheless, theory development is still under way and it remains to be seen whether the envisaged methodology for adapting and extending existing frameworks, the social-ecological systems framework being the first among those, towards the integrated analysis of SETS can be maintained or needs to be revised.

Keywords: socio-ecological-technical system, sewage system, sustainability, analysis framework, transformation processes

1. Introduction

Infrastructure systems, such as sewage disposal, constitute complex socio-technical systems providing a function essential to societies. For example, sewage systems are expected to ensure public sanitation and hygiene as well as the protection of water bodies. To fulfil these societal functions successfully, systems need to be able to flexibly adapt to changing conditions. These changes may be due to technological developments (like elimination of micro pollutants or increased efficiency), demographic changes, environmental impacts, increasingly strict environmental laws or other legislative changes, changing market environment (like liberalization), but also locally available capacities or massive investment needs. All these drivers increase the necessity for transformation processes by either developing new technologies or adapting the institutional set-up and initiating structural reforms (Gil and Beckmann, 2009). Accordingly, sustainable transformation of sewage disposal systems requires the adapted interaction between both development trends, bringing about infrastructure development that is accepted and desired by society. The author proposes that in order to provide effective and sustainable sewage disposal including accompanying services, transformation processes in the sanitation sector have to take into account both – socio-ecological and socio-technical aspects. So far, these domains have been analysed separately. The research presented here, therefore, aims at adapting and extending existing frameworks for the integrated analysis of socio-ecological-technical systems (SETS).

In recent years, the research into complex systems from an institutional economics perspective has tremendously gained momentum and several theoretical analysis frameworks have been conceptualized. However, no single framework in its current form offers the potential for analysing systems with dominant technological elements such as sewage disposal systems. Some proposed frameworks remain too general, while others are emphasizing the analysis of natural resources and their management. The integration of the technological domain is desirable as the sustainable development of societies is frequently based on technical innovation. Moreover, the selection of technologies and accompanying consequences has a significant impact on the system design. Nevertheless, existing frameworks already do capture a number of interrelations, dynamics, and variables relevant to developing an integrated framework for the analysis of SETS. Current efforts to further advance the field are targeting the operationalisation, formalisation, and verification of existing frameworks, as well as extending their application range. The research at hand shall continue and build on these efforts: The efforts of further developing the existing frameworks into a conceptual analytical framework for the analysis of SETS has been taken up. As a first step, patterns of sustainable system architecture need to be identified: Which technological and resource properties, policies, and socio-economic processes have an impact on the effectiveness and sustainability of SETS such as sewage disposal systems?

- What are the central elements characteristic for sustainable SETS from a system- and decision-theoretical perspective?
- Which relations and feedbacks on the same as well as across system and spatial levels shape sustainable SETS?
- How do the social, ecological, and technological spheres co-evolve against the backdrop of their situational socio-economic and institutional embeddedness?

The identified patterns and relations will provide a generalization and extension of the analytical frameworks used. The analysis of general patterns includes the objective to identify typical enabling or limiting factors concerning the system's ability to adapt to changing conditions. In a flexible system changes in the governance support new technologies, and at the same time new technologies are socially accepted and economically viable by meeting the requirements and needs of the population. This means that the emergence, dispersion preconditions and impacts of technological infrastructure developments are analysed on the example of sewages disposal systems. The final result of this currently on-going work is an extended framework able to cover all aspects (social, technological, and ecological) of complex systems in municipal settings.

2. Methods

In order to achieve the objectives of further developing existing frameworks into a diagnostic framework for analysing the effectiveness and sustainability of SETS, the research, as shown in figure 1, is divided into two main steps, combining both theoretical and empirical methods.

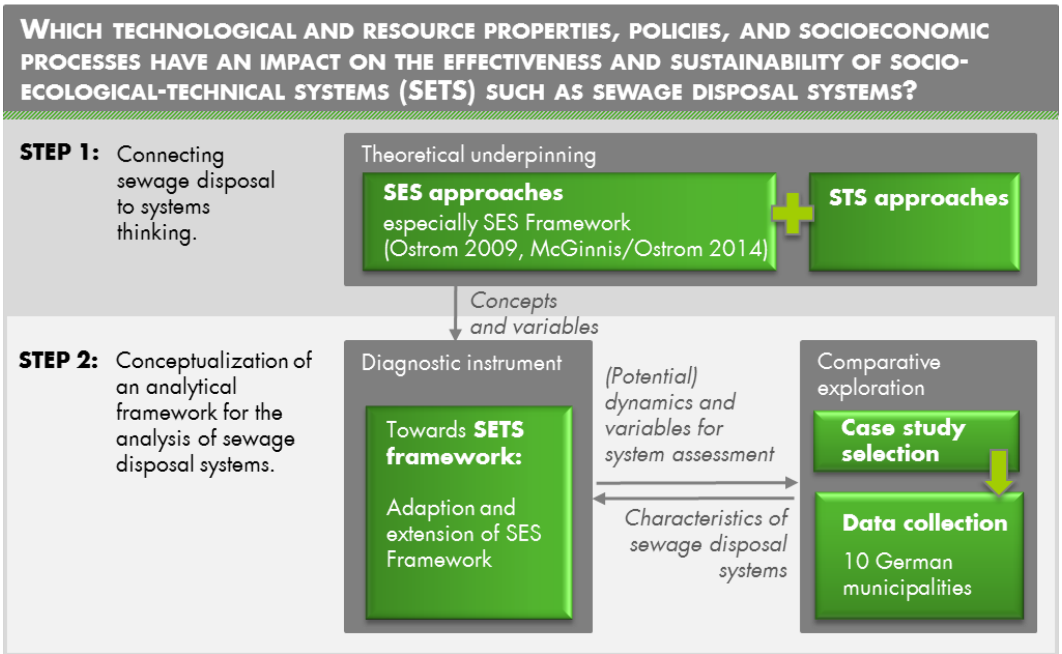

Figure 1: Methodical approach for theory development and validation. SES – Social-ecological system, STS – socio-technical system, SETS – social-ecological-technological system. (Source: Author's own diagram)

As a first step, existing theoretical approaches are assessed regarding their explanatory potential for the intended integrated analysis framework. As result (cf. section 3) of this literature-based exploration of different theoretical approaches the s*ocial-ecological systems (SES) framework* by Ostrom (2009) in the adapted version by McGinnis and Ostrom (2014) has been selected as starting point for theory development. Moreover, concepts and variables of the *Management and Transition Framework (MTF)* (Pahl-Wostl et al., 2010) and the *Human Environment Systems (HES) framework* (Scholz et al., 2011) are included, as well, to cover additional aspects of SETS not yet captured by the SESF. However, the SESF has originally been conceptualized for addressing resource management issues typically associated with common pool resources such as roving bandits effects (Olson 1993). Therefore, while engineered system components are taken into account within the SESF, the description of the technical domain remains rudimentary. Accordingly, additional insights and variables are needed to extend the SESF towards an integrated SETS Framework. For gaining these insights, approaches focussing on the analysis of socio-technical systems (STS) are assessed. Among the socio-technical approaches deemed relevant are *transition management (TM)* (e.g. Frantzeskaki and Loorbach, 2010) *strategic niche management (SNM*) (e.g. Geels and Schot, 2008), and the *multi-level perspective (MLP)* (e.g. Geels 2005 and 2006; Markard and Truffer, 2008). As a result of this step, a number of theoretically relevant concepts, interrelations, dynamics, and variables for describing the three different domains of SETS are identified.

As second step, the SES framework is extended and adapted towards a SETS framework on the example of sewage disposal systems. For this purpose, the infrastructure system is firstly characterized by the existing SES variables as comprehensively as possible. Where necessary, the HES and MTF frameworks will be called upon to describe the social and ecological domains in more detail. Additionally, insights from STS complement the conceptualization of the technological system characteristics and are embedded adequately in the SETS framework.

This theoretical effort of literature-based exploration and framework formulation is reconciled with empirical findings resulting from comparative exploration of case studies. The detailed analysis of ten municipal sewage disposal systems will provide insights on the characteristics of these systems such as technological and management options, existing path dependencies, their socio-economic environment, and attributes of the framing ecosystem. As the research presented here is an on-ongoing effort, results of this working package are not yet available. Regardless, in the following the proposed approach for the empirical analysis will be briefly presented.

As cases, municipalities will be selected from prior research projects in the sanitation sector that are or have been facing strong pressure to change due to either changing framing conditions such as reduced water consumption, demographic and migration trends, or massive re-investment needs. To cover a large variety of systems, selected case studies will include municipal sewage systems with comparatively small and large catchment areas as well as a combination of centralized and decentralized managed sewage networks. It is aimed to select municipalities that at least partially (e.g. in peripheral areas) have shifted to innovative sewage disposal options.

Once the cases are selected and the theoretical framework is in place, data on recurring concepts and variables across cases will be collected and compared with the proposed framework. This synchronisation might include both, the confirmation of potentially explanatory variables added to the SETS framework as part of the theoretical endeavour as well as the identification of additional variables that seem common characteristics based on the empirical evidence of the analysed municipal systems. First, in order to capture the conditions of the embedding environment of the selected cases, the dynamics, categories, and variables of the theoretically developed SETS will be used to describe the infrastructure systems. These variables have to be complemented by data on the various relations of technological systems and their socio-ecological framing conditions (e.g. nature-space conditions, market conditions, user preferences and consumption patterns, environmental and other legal regulations) that need to be considered also. This data is for the most part either publicly available (e.g. statistics on demographic trends) or has been collected during previous infrastructural projects at the Institute for Infrastructure and Resources Management. Additional data will be gathered with semi-structured interviews during field-visits and surveys in cooperation with the respective municipalities. Second, to describe the respective SETS architecture on the other side, suitable technological options (individual technologies and local infrastructure systems) available to the selected municipalities have to be recorded and characterized concerning their current development status. By doing so, it needs to be considered that larger technological systems, i.e. the local sewage disposal system are composed of multiple subsystems (e.g. catchment areas of technological structures such as a wastewater treatment facility) and apply different technologies (e.g. type of wastewater treatment facility, separate or combined system for wastewater collection and transports. All of them are associated with specific demands towards their system environment and the potential to develop asymmetrically in regard to other technologies of the overall system. Nevertheless, a sufficient number of case studies will allow for the identification of such underlying structural patterns within integrated socio-technical systems and their socio-ecological framing conditions.

The final result of this step is an extended and dynamic framework able to cover all aspects (social, technological, ecological) of complex systems in municipal settings in a consistent and theoretically informed way.

3. Intermediary results and discussion

In accordance e.g. with Berkek et al. (2006) or Ostrom (2007) the author strongly believes that no single approach alone can successfully solve the problems associated with planning, implementing, and managing complex systems but an interdisciplinary approach is needed. Therefore, while the analysis is conducted from the perspective of institutional economics, the methodology applied here draws on findings from two broad fields of theoretical research. On the one hand, existing theoretical frameworks analysing SES, including socio-technical infrastructure, provide the basis for developing an integrated framework. Additionally, existing research from the field of sustainability transition studies is suitable to capture further aspects of the technical domain and characterize engineered system components in detail.

3.1 Social-ecological approaches

The analysis of socio-ecological relations has been strongly influenced by the works of Elinor Ostrom. One major result of her research has been the *SES framework* (Ostrom, 2007 and 2009; refined by McGinnis and Ostrom, 2014). This framework has been derived from empirical case study analysis and in its essence, highlights that each system is composed of several subsystems, namely that there are “layers” of systems nested within each other. Each subsystem may be analysed individually as long as its interconnectedness to other hierarchical levels and systems is taken into account. Second, this approach is based on the insight that panaceas (i.e. one size fits all solutions) normally fail to do justice to SES’s individual local complexity. The SES framework is aimed at answering the following broad questions:

- What pattern of interactions and outcomes (e.g. overuse, conflict, stability) are likely to result from using a particular set of rules for the governance, and use of a resource system in a specific technological, socioeconomic, and political environment?
- What is the likely endogenous development of different governance arrangements, use patterns, and outcomes with or without external financial inducements or imposed rules?
- How robust and sustainable is a particular resources system configuration to external and internal changes?

Originally, the SES framework has been conceptualized for analysing the likelihood of self-organization regarding the governance of common-pool resources (CPR), or common goods, such as alpine pastures, agricultural irrigation systems, or coastal fisheries. Hence this diagnostic instrument primarily targets resources systems and is not aimed at the analysis of systems with mostly engineered components. Recent application however extended the application range to public goods and there have been first attempts at describing systems with dominantly engineered components, as well, but the technological perspective is still being addressed only rudimentary within the diagnostic instrument (McGinnis and Ostrom, 2014). Nonetheless, a major advantage of this framework is that Ostrom conceptualized it in order to cumulate knowledge of multiple disciplines in one common framework.

Among other frameworks that were explicitly designed to allow for such interdisciplinary reasoning about complex socio-ecological problems, *the MTF* (Pahl-Wostl et al., 2010) and the *HES framework* (Scholz et al., 2011) also seem to be promising for the approach chosen here. The objective of the MTF is to support the understanding of water systems and management regimes, as well as transition processes toward more adaptive management. It has been designed to enable comparative analyses of a wide range of diverse case studies, and to facilitate the development of simulation models based on empirical evidence (Pahl-Wostl et al., 2010). Furthermore, the MTF can be applied on any level, even though it favours the regional or national scale. However, being designed from an anthropocentrical view point, within the MTF ecological system dynamics are not addressed in detail. Nevertheless, due to its integrative nature, the MTF seems to be a further promising starting point for the development of a SETS framework. The *HES framework* has been designed as a heuristic tool for providing a structure for the analysis of socio-ecological interactions, understanding the processes and dynamics between the social and ecological systems as well as within different scales of the social system, examining learning processes over time (sustainability learning), and exploring human-activity related environmental problems (Scholz et al., 2011). Accordingly, it can be applied at any scale, but is especially suitable for investigating complex systems comprising multiple hierarchical levels in both the social and the ecological system. In sum, even though the HES framework does not explicitly consider the dynamics within the ecological system, it provides an understanding of the decision making processes and also supports the development of models for the selected question posed.

Among the above mentioned frameworks, the revised SES framework as proposed by McGinnis and Ostrom (2014) has been selected to serve as a starting point for the integration of the technological and socio-ecological perspectives as “it is the most general framework, and the data collected within its structure could potentially be used in any of the other frameworks [for analysing socio-ecological systems]” (Binder et al., 2013). It explicitly has been designed to enable and facilitate communication between disciplines by developing a theory-neutral, universally applicable vocabulary, and is furthermore consistent with a large number of theories from different fields and aims. Hence, it is not only open for adding insights from additional fields such as technological infrastructure research, but among the three frameworks – SES, MTF, and HES – only the SES framework considers the ecological and social system in almost equal depth and thus provides an ideal starting point for adding the technical sphere.

3.2 Socio-technical approaches

All of the above frameworks fail to consider the specific characteristics of dominantly technological systems. Since these characteristics (such as path dependencies associated with technology selection) are highly relevant when discussing transformation towards a new, more sustainable system state, the theoretical approaches (e.g. Kemp et al., 1998; Rotmans et al., 2001; Geels, 2002; Markard and Truffer, 2008; or Bergek et al., 2008) from research on the transformation of STS will serve as an additional source of information for adding a dynamic perspective to the SETS framework. In order to analyse these complex, multi-level systems, the application of system thinking has led to the development of several conceptual frameworks for examining socio-technical transformation processes. Among these, the most commonly applied research strands of *TM* (Rotmans et al., 2001; Voß et al., 2009; Frantzeskaki and Loorbach, 2010), *SNM* (Kemp et al., 1998; Geels and Schot, 2008), and the *MLP* (Geels 2002, 2005a, 2005b, 2005c, and 2006; Markard and Truffer, 2008) are considered as potential sources for indications on how to add a dynamic perspective to the to-be-developed SETS framework:

By combining system theory, governance approaches, and technological transformation, *TM* offers practice-oriented guiding principles for influencing ongoing transformations into more sustainable directions (Loorbach, 2010). These principles are derived from conceptualizing sectors like water management as complex multi-level social systems within which evolutionary adaption processes take place. Accordingly, transition management of these systems is seen as a reflexive and evolutionary governance process (Voß et al., 2009) and has been operationalized as a mixture of “problem structuring and envisioning in multi-stakeholder arenas, developing new coalitions, implementing agendas in experiments, and evaluating and monitoring the process” (Markard et al., 2012). *SNM* centres on creating and supporting “niches”, a central concept in transformation research, which initiates regime shifts. Such niches are understood to be protected spaces such as a specific field of application or markets, in which innovations can be tested out and develop without being exposed to the selection pressure of the predominant regime (Kemp et al., 1998). These niche innovations are expected to further develop and gain additional impetus through social learning processes until they can eventually compete with established technologies of the predominant regime. Finally, the *MLP* builds upon the concept of the niche, as well, and explains technological transformation as interrelation of dynamics at three hierarchical levels: niches, regimes, and landscapes (Geels, 2002). Factors of the landscape, i.e. the macro level superordinate to the socio-technical system, may exert pressure on existing regimes, thereby opening opportunities for niche technologies to break through and thus facilitating a fundamental shift in the socio-technical regime. In this perspective, transformation can follow different types of transformation pathways depending on timing and qualitatively different niche-regimes-landscape interactions (Schot and Geels, 2008).

All-in-all, it can be stated that contributions from transformation research (as described above) provide another fruitful starting point to conceptualize the technical domain of SETS as well as analyse, and reflect upon systemic change and sustainable transformation of infrastructure systems. Nevertheless, a number of shortcomings create the need of further research. First, approaches centring on the concept of niches such as the SNM and MLP have only a limited application potential for systems with extensive physical stock. This is due to the strong path dependencies and associated sunk costs of grid-bound infrastructures as well as the interrelations within SETS. Second, TM approaches, as they are emphasizing the role of interactions and reciprocal adaption, or co-evolutionary processes, or focussing on the facilitation of socio-technical transformation such as infrastructure systems are more suitable. Lastly, the disadvantage of TM consists in its scale of application. By concentrating on the analysis at the macro level, these approaches offer little potential for analysing specific case studies and deriving concrete recommendations on how to respond to existing governance challenges at the level of municipalities, as it is planned here.

3.3 Towards a social ecological systems framework

In sum, the frameworks discussed above all suffer from a unilateral approach, focussing either on human-environment relations or revolve around the transformation of the technological system. In its current form, no framework addresses the social, ecological and technological system in equal depth. Nevertheless, they already capture several dynamics, interrelations and variables facilitating the development of such an integrated analytical instrument. Therefore the adaption and further development towards a framework for the analysis of socio-ecological-technical systems (STEP 2, cf. figure 1) is guided by existing frameworks, thus allowing for a synthesis of all relevant domains.

As laid out in section 3.1, the SES framework shall serve as basis for the SETS framework. Accordingly, in a first step existing SES variables serve to describe sewage disposal SETS as far as possible. It is expected that the variables in their current form will be able to characterize the system in question only partially, especially with regards to recording technological aspects. Therefore, on the one hand, the understanding and interpretation of SES variables is adapted. Ostrom's framework, as shown in figure 2, is comprised of four first-level core subsystems and multiple second-level variables for each of the core subsystems. The latter are further specified by deeper-level variables and indicators. These variables at lower tiers, are selected case specific to enable this broad framework to flexibly address different local specifics and peculiarities. Variables on the top or second tier, however, are assumed to remain equally relevant to all applications. (McGinnis and Ostrom, 2014) Regardless, not all variables are meaningful for every application. Hence, when applying the framework, variables not relevant for describing the system at hand may be left out. The findings of a recent meta-analysis carried out by Thiel et al. (2015) re-evaluating 20 articles applying the SES framework for documenting empirical data confirms that different variables have been used with different frequency. Interestingly for the context of this work - if not surprising due to the focus of SES framework application on managing natural resources - is that the two variables that have been used least by far, are variables directly referring to technology. The variable "Actors 9 - Technology used" for example has been used in only one paper, while the variable "Social, Economic, and Political settings 8 - Technology" has not been taken into consideration at all as explanatory variable. The author speculates, this might indicate that interpretation of SES variables referring to engineered system components is difficult and additional efforts in this area are needed.

Social, Economic, and Political Settings (S)
S1– Economic development. S2– Demographic trends. S3– Political stability. S4– Other governance systems. S5– Markets. S6– Media organizations. S7– Technology.

Resource Systems (RS)

RS1– Sector (e.g., water, forests, pasture, fish)
RS2– Clarity of system boundaries
RS3– Size of resource system
RS4– Human-constructed facilities
RS5– Productivity of system
RS6– Equilibrium properties
RS7– Predictability of system dynamics
RS8– Storage characteristics
RS9– Location

Governance Systems (GS)

GS1– Government organizations
GS2– Nongovernment organizations
GS3– Network structure
GS4– Property-rights systems
GS5– Operational-choice rules
GS6– Collective-choice rules
GS7– Constitutional-choice rules
GS8– Monitoring and sanctioning rules

Resource Units (RU)

RU1– Resource unit mobility
RU2– Growth or replacement rate
RU3– Interaction among resource units
RU4– Economic value
RU5– Number of units
RU6– Distinctive characteristics
RU7– Spatial and temporal distribution

Actors (A)

A1– Number of relevant actors
A2– Socioeconomic attributes
A3– History or past experiences
A4– Location
A5– Leadership/entrepreneurship
A6– Norms (trust-reciprocity)/social capital
A7– Knowledge of SES/mental models
A8– Importance of resource (dependence)
A9– Technologies available

Action Situations: Interactions (I) → Outcomes (O)

Activities and Processes:

I1– Harvesting
I2– Information sharing
I3– Deliberation processes
I4– Conflicts
I5– Investment activities
I6– Lobbying activities
I7– Self-organizing activities
I8– Networking activities
I9– Monitoring activities
I10– Evaluative activities

Outcome Criteria:

O1– Social performance measures (e.g., efficiency, equity, accountability, sustainability)
O2– Ecological performance measures (e.g., overharvested, resilience, biodiversity, sustainability)
O3– Externalities to other SESs

Related Ecosystems (ECO)
ECO1– Climate patterns. ECO2– Pollution patterns. ECO3– Flows into and out of focal SES.

Figure 2: First-tier and second-tier concepts of the Ostrom (2009) social-ecological system framework, including minor refinements made by McGinnis and Ostrom (2014)

(Source: Hinkel et al. 2015)

For those aspects of sewage disposal SETS, that cannot be captured even by adapted SES variables, the framework needs to be extended. Insights from the SES and STS approaches discussed above will provide the theoretical basis for potentially introducing new categories and variables, as well as embedding them into the frameworks structure.

As already mentioned, this is the step currently under way. Accordingly, no final results on which concepts and variables are included in the final SETS framework or on the subsequent steps of case study selection and analysis are available yet. Instead, the general approach taken for the adaption of SES variables, or their re-interpretation for highly technical systems of sewage disposal infrastructure, and accompanying challenges shall be presented on the example of the two subsystems “Resource Systems (RS)” and “Resource Units (RU)”.

As a prerequisite for this step boundaries of the study object, namely the sewage disposal system comprising the processes of draining and treating waste water, are defined. According to Göpel (2015), all complex systems in general are composed of a purpose, of stocks, and of flows. In case of sewage disposal the purpose of the system, as given above, is to ensure public sanitation and hygiene on the one hand, and to protect water bodies on the other hand. The stocks of a system comprise material and immaterial components such as the technological components and (bio-)physical structure of the sewage network and waste water treatment facilities, but also the stakeholder or immaterial components such as information. The interconnections, dynamics, and feedback loops between the stocks of the system are subsumed as flows. These materials, information or energy determine changes in each stock's quality or quantity, depending on their interrelations or feedback loops. In a sewage system manifold flows exist and include, for example, the production and drainage of waste water, operating, maintaining, and monitoring the sewage disposal system, or enforcing accompanying policies and regulation. All these components, as summarized in table 1, need to be taken into consideration for system assessment. Accordingly, the to-be-developed SETS framework needs to be able to capture all types of system elements and their potential local forms of manifestation.

Table 1: Components of sewage disposal systems (Source: author's compilation)

System components	Sewage disposal system
Purpose	Ensuring ▪ public hygiene and sanitation ▪ the protection of water bodies
Stocks	Elements of technical infrastructure; (bio-)physical structures of ▪ sewage drainage (sewage network) ▪ waste water treatment (central and decentralized treatment facilities) Actors Immaterial elements e.g. information
Flows	Plentiful, e.g. the production of waste water, the drainage of waste water, operating, maintaining, and monitoring the sewage disposal system, or enforcing policies and regulations (legal requirements, terms and conditions of local sewage disposal, property rights, etc.)

To achieve this objective, the diagnostic procedure detailed by Hinkel et al. (2015) for "conceptualizing SES and analysing governance challenges using the SES framework" (ibid.) has been adopted. They suggest a sequence of ten questions to identify the actors involved, the benefits obtained by them, and so-called collective *action situations* influencing the generation of such benefits. "Action situations" originate from Ostrom's Institutional Analysis and Development framework (IAD) and are also at the heart of the SES framework (Ostrom, 2011). They structure actors' pattern of interaction by describing situations "in which individuals (acting on their own or as agents of formal organizations) interact with each other and thereby jointly affect outcomes that are differentially valued by those actors" (McGinnis and Ostrom, 2014). Now, coming back to RS and RU variables, their general role is to describe governance challenges relating to two types of situations, appropriation action situations and provisioning action situations (Hinkel et al., 2015). In provisioning situations, actors collectively face a challenge to provide, i.e. to construct, to maintain, or to improve collective goods (understood here as category comprising both public goods and common-pool resources). Provision problems are often asking for incentives to avoid free-riding of participants. In appropriation action situations actors face the need to avoid overuse of a collective good in order to prevent welfare losses by responding with incentives for participants to limit their consumption to an acceptable level in order to sustain the stock of corresponding resource units. Following the interpretation of Hinkel et al. (2015), appropriation action situations hence "consist of actors carrying out activities that (1) depend upon a common stock, and (2) subtract from that stock. Only pure public goods (with zero subtractability) are excluded from this definition." Transferred to sewage disposal, appropriation and provisioning situations have been identified as follows (table 2):

Table 2: Appropriation and provisioning action situations for sewage disposal systems.

RU = resource units, RS = resource system. (Source: based on Hinkel et al., 2015)

Actors	Benefits	Activity	Stock of RU	Subtract-ability	RS	Provisioning action situation
Residents/ Enterprises in the catchment area	Health protection,	Draining waste water	Waste water disposal capacity	Low-medium (case specific)	Sewage disposal infra-structure (private and municipal facilities)	Sewerage providers operate municipal sewage disposal system and monitor proper operation of private, decentral facilities
	(Possibly) reduced waste water charges	(Possibly) treating waste water decentrally				
	Revenue	selling/using by-products	Nutrient concentra-tion in waste water	No (usually own waste water)		

Several focal appropriation action situations are associated with effective sewage disposal as local residents and enterprises have the characteristics of prosumers, combining attributes of both users and produces.

On the one hand, they produce waste water that is drained for centralized treatment, thus acting as users of the system benefitting from improved sanitation and hygiene. But what is the limited stock in a sewage disposal system comprised of subtractable resource units connected to these benefits? A wider interpretation of “stock” and “resource unit” is applied for translating these concepts to a highly technical system. In contrast to the standard resource extraction problem (e.g. farmers extracting water from an irrigation system as presented by Cox, 2014) where the stock of RU is easily identified (e.g. the water quantity available in the agricultural irrigation system), certainly no user will compete for an extra share of waste water as long as they cannot generate any profit from it. Waste water per se, hence, cannot be the RU. Instead, relevant stocks impacted by draining a larger or smaller amount of waste water are the draining capacity of the sewage network and the size of waste water treatment facilities specified in population equivalents. Therefore, it is proposed here, to define the stock of RU as waste water disposal capacity. Subtractability is low to medium, depending on the specific utilization capacities of the sewage system in place. As sewage systems are designed to cope with peak loads, subtractability outside these peaks will be low. On the other hand, if maximum capacities of a specific sewage system are reached on a regular basis, users might often not be able to discharge their waste water immediately but have to wait. As they regardless will be able to discharge their waste water as soon as the capacities become available again, subtractability in such cases is considered medium.

Then again, if decentral treatment options are employed in the local catchment area, and residents and enterprises are treating their waste water completely or partially in decentral facilities on their own premises, they might achieve a substantial reduction of (or exemption from) waste water charges, which at least in Germany otherwise are obligatory to pay due to compulsory connection and usage. Moreover, they might utilise or sell nutrients extracted from their waste water or by-products of waste water treatment such as biogas, thereby generating revenue. Thus, they move from consumer to producer. Regarding afflicted stocks of resources, the share of waste water charges that may potential be saved is assumed to also be directly linked to the utilization of central drainage and treatment capacities. For example, if existing central capacities become increasingly insufficient for all arising waste water within the catchment, sewage providers are much more likely to grant financial incentives for decentralisation. Or due to changing framing conditions such as depopulation of rural area, municipal authorities might decide to gradually switch from centralized treatment, calling for the operation and maintenance of expensive sewage networks, to decentralized facilities and provide incentives to residents and enterprises to accelerate this transition. The revenue generated from selling or the generated savings from utilising e.g. the amount of nutrients or the by-product biogas depends on the composition of the waste water, especially the nutrient concentration. The corresponding stock is considered not to be subtractable as the dimension of decentral sewage systems is adapted to the waste water volume of the connected dischargers.

As an institutional response to these action situations, governance bodies (e.g. water authorities) responsible for the infrastructure are in place to set the rules (e.g. specifying levels of requirements for the cleaning performance of the system to ensure the protection of receiving water bodies) framing the selection of technological options, accompanying business models, and their implementation at the local level.

The interpretation of the RS variables is more straightforward, than determining the stock of RU. Overall, SETS are quite similar to SES if the RS is considered the technological subsystem, as the social side does not seem to differ in both cases. (Hinkel et al., 2015; McGinnis and Ostrom, 2014). In accordance with this estimation the RS has been determined as the entirety of local sewage disposal infrastructure regardless of ownership structure (private and municipal facilities) and variables at the second tier interpreted accordingly, as shown in table 3.

Table 3: Conceptualization of resource system (RS) variables of the SES framework as technological subsystem (Source: author's compilation based on McGinnis and Ostrom, 2014)

Second-tier variables detailing the subsystem "Resource Systems"		**Sewage disposal system**
RS1	Sector	Sewage disposal
RS2	Clarity of system boundaries	Clear for RS = technological subsystem (catchment area)
RS3	Size of resource system	Case specific
RS4	Human-constructed facilities	Technical infrastructure (sewage network, waste water treatment facilities)
RS5	Productivity of system	Case specific
RS6	Equilibrium properties	Input and output correspond quantitatively (assumption: no water losses e.g. due to deteriorated infrastructure, no unwanted infiltration water)
RS7	Predictability of system dynamics	▪ Technical subsystem: high predictability ▪ Socio-economic subsystem: case specific (depends e.g. on the behaviour of other actors, or on the effectiveness of sanctioning mechanisms in place)
RS8	Storage characteristics	Supply capacities of the sewage network (e.g. dimensions of duct diameter)
RS9	Location	Spatial distribution of material system components (e.g. distance to the central waste water treatment plant/ receiving water bodies)

Responding to the provisioning governance challenge requires the set-up, operation and maintenance of municipal sewage disposal system and monitoring of proper operation of private, decentral facilities by sewerage providers.

Besides the action situations described so far, a number of further action situations must be considered for SES analysis and shall be transferred to SETS analysis. According to McGinnis and Ostrom (2014) "all of the factors included in top-tier categories [are], at least potentially, both inputs to and outputs from one or more action situations. Action situations take as inputs the values of the SES top-tier categories at time t and generate changed values of at least some of those factors at time t+1." Such further situations include monitoring or operational choice, collective choice, and constitutional choice action situations (Hinkel et al., 2015). Accordingly, the currently on-going research effort focusses on completing the representation of all action situations potentially occurring in different sewage disposal systems.

The procedure presented above of identifying action situations has been extended for describing SETS. It is hoped, that by interpreting SES variables in conformity with their role in explaining outcomes, instead of simply interpreting SES variables per se, it will be easier to identify further aspects of SETS, which existing (adapted) variables do not or do not comprehensively capture. Thus, it is expected that as a results, entry points for adding new categories and variables will be provided. Whether this hope is justified, remains to be seen in the course of the work.

4. Conclusions

In conclusion, a methodological approach for developing a diagnostic framework for the integrated analysis of sewage disposal SETS has been proposed herewith. Until now, existing frameworks have been proposed either for the analysis of SES or STS but not for an integrated assessment of all three domains – social, ecological and technological – included in SETS.

By identifying potential explanatory concepts and variables via literature-based exploration of existing frameworks for both SES and STS analysis as a first step, the SES framework (McGinnis and Ostrom, 2014) has been selected for adaption and extension towards a SETS framework for sewage disposal systems. Moreover, among further SES approaches the MTF and the HES framework have been identified as useful addition for the comprehensive description of the social and the ecological subsystem of SETS, while TM, SNM, and MLP approaches are expected to be a promising source for indications on further detailing the technological domain. Which SES and STS concepts and variables will be included in the final instrument, is determined in the subsequent theory development phase. It combines both theoretical and empirical analysis. At the theoretical level, potential explanatory variables of a SETS framework on the example of sewage disposal are identified, while at the applied level, these proposed variables for SETS assessment are re-examined by testing them via case study analysis of ten municipal sewage systems. Where necessary, proposed categories and variables will be revised in accordance with the empirical findings obtained.

First results of this currently on-going second step seem promising with regards to the feasibility of the chosen approach. At the moment, interpretation of SES framework variables is adapted for the representation of sewage disposal SETS, before next, explanatory variables needed for capturing further aspects will be added to the framework where necessary. By identifying action situations typical for sewage disposal systems, the interpretation of two of the four core subsystems included in the SES framework, namely the RS and RU subsystems, has been successfully adapted and transferred to describing corresponding subsystems of a SETS framework. To structure the SETS along the lines of the SES framework seems possible, as both systems are remarkably similar, if the RS subsystem is viewed as the infrastructural system. Nevertheless, theory development is still in progress and it remains to be seen whether the envisaged methodology for adapting and extending existing frameworks - the SES framework being the first among those - towards the integrated analysis of SETS can be maintained or needs to be revised.

In any case, it is to be expected that the final instrument to-be-developed will only be a contribution towards the research efforts of introducing a consistent framework suitable for the analysis of all kind of SETS, as the SES framework claims for SES analysis. Still, the self-imposed goal demands that a framework applicable to a wide range of sewage systems will have been elaborated. With such a framework an instrument for a better understanding of successful transformation in the field of municipal infrastructure will be provided.

Further extension of such an instrument towards a general SETS framework could target, for instance, the inclusion of other subsystems of sanitation systems interacting with the sewage disposal systems such as rain water management or flood protection. Alternatively, the proposed sewage disposal framework could be tested for cases from an international context, representing “typical” sewage disposal configurations, to further validate the applicability and transferability of the SETS framework to diverse cases or serving as feedback loop for further refinement of this diagnostic tool.

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Transport Infrastructure Project Evaluation: Transforming CBA to include a more encompassing Life Cycle Perspective

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Abstract

Major transportation infrastructure projects are often megaprojects that have been plagued by cost and schedules overruns and are subsequently loudly criticized. This focus along with the magnitude of the investments creates a need to carefully assess the costs and benefits of infrastructure projects. Most countries and international organizations have selected CBA as the evaluation tool to be used, therefore it is important that CBA be as complete and transparent as possible and accurately indicate the most efficient investment. There is a distinct lack of looking at CBA from a life cycle perspective. In order to avoid potentially misleading results, the investment must be examined over the entire life of the project. The environmental impacts are only considered during the operation phase and little attention is paid to how the project is accounted for at the end of its life.

The aim of this research is to account for the environmental impacts for the entire life cycle of the project and to better reflect the value of the project at the end of its life. Transforming CBA to include a life cycle perspective will be accomplished by performing, monetizing and including a life cycle assessment (LCA) into the CBA and exploring and recommending methods for value of the investment at the end of its lifetime (residual value). To determine the impact of these advancements on policy and decision making, the case study of the Lisbon to Porto HSR link is used. The findings of this research have real implications on policy and decision making and the methodologies used to determine the economic impact of major infrastructure investment projects. The inclusion of LCA into CBA provides a more inclusive life cycle perspective of the environmental impacts arising from an infrastructure investment project. Using a component method to calculate residual value provides a more complete and transparent accounting of the project and furthers the goal of life cycle perspective. By utilizing the recommended advancements, the life cycle costs and benefits can be quantified and advocate that the HSR link should have been constructed.

Keywords: Cost-benefit analysis, Life cycle assessment, residual value, environmental impacts, hyperbolic discount rate

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Theme 1. Sustainable Development Science

Track 1a. Sustainable Development Science: Fundamental Concepts

Track 1b. Sustainability Assessment and Indicators

Track 1c. Role of Academia

Track 1a. Sustainable Development Science: Fundamental Concepts

Session 1a-08

The use of green coagulants for sustainable water treatment

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Abstract

The search for natural coagulants more environmental friendly and sustainable in water treatment have already began. Chemical coagulants are responsible for large sludge production, need pH and alkalinity adjustments, and remain in treated water. In addition, some coagulants, like aluminium, are linked with neurodegenerative diseases as Alzheimer, and others, like synthetic organic polymers, have neurotoxic and carcinogenic effects. In contrast, the main benefits of natural coagulants, especially those of vegetable origin, are safe to human health, eco-friendly and in general toxic free, highly biodegradable, pH stable, low cost with the possibility of large scale production, and low sludge production.

Moringa oleifera Lam is a fast-growing, drought-resistant tree, native to the southern foothills of the Himalayas in north western India, and widely cultivated in tropical and subtropical areas where its young seed pods and leaves are used as vegetables. *Moringa oleifera* Lam seeds are organic natural polymer. It is one of the most natural coagulants currently studied for water purification. Its efficiency has been demonstrated for high colour and turbidity waters, especially when extraction of active components of the seeds is made. *Moringa oleifera* Lam seeds active coagulant by oil extraction, salt extraction, dialysis, micro and ultra filtration techniques have been proposed to improve turbidity removal.

This study investigates the effectiveness of the coagulation/flocculation/sedimentation (C/F/S) and coagulation/flocculation/dissolved air flotation (C/F/DAF) processes for turbidity removal from surface water using *Moringa oleifera* as natural coagulant. *Moringa* seeds were used without any extraction of the active coagulant compound, so as integral powder. The idea was analyse *Moringa* seeds as a whole, because will it reduces the cost and the time in water treatment plants. Results show removals of up to 90% for high turbid waters (65-180 NTU) using 50 mg/L of *Moringa* powder and C/F/S processes. However, turbidity removals for low turbid waters (3-5 NTU) are very low 0-10%. Results also show that when using C/F/DAF processes, turbidity removals increase to ~40% for low turbid waters (5 NTU) and to 75% for medium turbid waters (30 NTU). These promising results demonstrate that *Moringa oleifera* Lam is a viable alternative to diminish the use of chemical coagulants in the clarification of surface waters, which represents a more sustainable option to the water treatment managers.

Keyword: *Moringa oleifera*; Natural coagulant; Coagulation; Flocculation; Water treatment.

Affective Sustainability: Exploring Beyond the Models of Sustainable Development

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Abstract

Sustainable Development has become a typical expression appropriated in environmental, social, and economic debates. This excessive appropriation permits the reproduction of conflicting definitions for the expression, which generate tough challenges and some stagnation in the adoption of effective measures and practices towards sustainability. The model of the three pillars for sustainable development, already contested by cultural perspectives on the topic, will be explored in this paper through an aesthetic approach which denotes the importance that the affective dimension of sustainability has on the knowledge formation about the topic. Aesthetic experience, understood as a multi-sensorial perception of the world, instigates the comprehension of the relationship between the body and the environment as a process of constant interaction and continuity and which cannot have a finished end. Just as our relationships to our environment can never have a finished and stagnated model, the aesthetic experience enables an ongoing transition in a rhythm of flux and stability of a continuous process of becoming – an uninterrupted perception of the senses. Recognizing the aesthetic dimension of sustainability is a fundamental step to reconsider our immediate interaction with the world, the impact of individual and collective practices, and the consequent responsibility to environmental protection. Furthermore, this process of recognition emphasizes the importance of a mindful and embodied perception of time and space. In this sense, the aesthetic dimension of experience and its relation to environmental perception and sustainability involve levels of complexity which go beyond the issues of the human-nature relation, or the inter- and intra-generational wellbeing. This complexity reaches to the formation of human self-identity and the comprehension of individual and collective values adopted in personal lifestyles as inescapably connected to a wider sense of 'environmental-self' and an 'ecosystemic wellbeing.' Hereupon, through methods of phenomenological and arts-informed research, the values adopted in alternative lifestyles (as for example, the slow movement and the de-growth) are analyzed and compared to the goals and definitions established in the models of sustainable development. These approaches are introduced to explore the processual characteristics of knowledge formation through embodied experience and to emphasize the importance of researching the affective dimension of sustainability at individual and collective levels. Thus, the aesthetic perception, arts-informed research, and their affective dimension present significant contributions to the discussions regarding the values shared in and for sustainability. They instigate the creation of different meanings to the relationships that are established to the environment, meaningful ways of knowledge formation and sharing through a closer connection to people (and other living beings), and a slower apprehension of life and wellbeing.

Keywords: Affective Sustainability, Aesthetic Experience, Alternative Lifestyles, Arts-informed Research

Engaging in sustainable development: the worldview approach

Bert de Vries

Abstract

The background to my paper is 12 years of teaching the course Sustainability Science at Utrecht University, in combination with 35 years of energy and climate modelling and policy analysis (see www.sustainabilityscience.eu and http://www.uu.nl/staff/BJMdeVries/0). The main question addressed is to improve how students – and people in general – can engage with the value- and belief-aspects of sustainable development in an interdisciplinary scientific setting. The aim is to provide a heuristic tool: the worldview framework, that introduces students to a variety of perspectives on specific sustainability issues (defined primarily as attempts to preserve and enhance the quality of life). A worldview is defined as a particular set of values and beliefs in relation to specific sustainability issues, e.g. the energy transition and climate change, nature preservation, food provision and quality, urban transport, and water and resource systems. The research method is a combination of value theories, social surveys and systems modelling. The essence of the worldview approach is to learn to perceive events, trends and (causal) mechanisms as well as actors and interests in a larger context, as characterized by the two dimensions of matter-mind and local-global. It has been applied in the past decade in the form of group assignments, in which 3 or 4 students investigate various values and interests of relevant actors as manifested in their statements. The paper will describe some of the three dozen of assignments in detail, notably on the transition options in the energy arena and on emerging trends in food technology and diets, in order to illustrate and review the approach. The findings of applying this framework with students from a variety of backgrounds is that, particularly in an interactive and participatory setting, a better appreciation of the various stakeholders and their positions is acquired. This allows for more comprehensive search of the solution space, for instance by explicitly looking for the causes of disagreement, the possibility of alliances and the formulation of robust solutions. A preliminary conclusion is that the framework is comprehensive enough to deal effectively with a variety of sustainability issues, but that there is a need to incorporate better the insights from the social and innovation sciences. The paper ends with some suggestions in this direction.

Keywords: Sustainability science, worldview approach, value and beliefs.

Integral Approach to Historical Interaction between Human Activities and Hydrological Cycle in Dryland: A case study of Heihe River basin in Northwestern China

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Abstract

This article 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/interconnection 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 interaction between humanity and environmental changes in the Heihe River basin across the period 1944–2014. The proposed approach enables us to investigate the environmental problems of the Heihe River basin in a four-quadrant framework, and combine the empirics of quadrants obtained from traditional disciplinary methodologies. The four-quadrant framework adopted in this study illustrates the interlocking relationships among various quadrants of environmental issues in the Heihe River basin, namely, physical, personal, cultural, and social-systemic quadrants. In particular, we found that the protruding development of the lower right quadrant in the form of irrigation agricultural development, is the fundamental cause of environmental degradation in the Heihe 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. Compared to other established approaches in literature that emphasize on the tradeoffs of various perspectives of sustainability, our findings indicate the potential contributions to sustainability assessment through its focus on the inter-relatedness/inter-connection of different perspectives.

Keywords: Sustainability assessment, integral science, theory of everything, hydrological cycle, irrigation agricultural development

Track 1b. Sustainability Assessment and Indicators

Session 1b-01

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Observatories of Sustainable Development Goals State of Play in Community of Portuguese Language Countries

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Abstract

The emergence of the issue of climate change has raised discussions about the relationship and interaction between humans and the natural systems -- particularly with regard to the enormous acceleration and intensification of greenhouse gas emissions produced by humans since the industrial revolution. The great acceleration in the use of natural resources has caused/influenced that other problems have emerged strongly in recent years – problems related to the scale, distribution and temporality of climate change. This perception is somehow translated in the Resolution 70/1 "Transforming our world: the 2030 Agenda for Sustainable Development", resulting from United Nations General Assembly, signed on September 25th 2015, covering 17 Goals for Sustainable Development (SDGs). One of the challenges identified in this process is the availability of reliable as well as up to date data for analyzing and monitoring the progress. Another issue is that the SDG ranking shows the ranking but not the actual performance of each country. This work aims to show how the nine countries of the Community of Portuguese speaking countries (CPLP) face the SDGs, analyzing the current level of compliance and fulfilling of each country in relation to the objectives. This was analyzed by selecting three indicators for each objective. The indicators were normalized on a scale from 0--1 and the countries were classified according to a methodology of benchmarking as well as country comparison. The paper presents a weak sustainability analysis of the overall performance of the CPLP countries on all 17 goals and a country comparison analysis of economic, social and environmental sustainable performance as well as a comparison of country achievements in relation to the 13th objective: "urgent action to combat climate change". The fourth approach is Benchmarking. The results show that the countries are not balanced in social economic and environmental sustainable performance. the countries ranked highest in environmental sustainability performance are on the other hand struggling in social and economic performance. Portugal which is performing high in economic and social are low in environment. The countries achieving best on combatting climate change are Guinea--Bissau and Mozambique followed by Brazil and Timor Leste. The countries performing lowest on the 13th goal are Equatorial Guinea and Cape Verde followed by Portugal. This result states a potential risk factor that economic growth in developing countries can be due to lower performance in environmental issues. This shows the challenges of growth - that a long term development has to be sustainable in all the social, environmental and economic issues. However it's possible to note that issues related to "economic growth", "access to energy" and "hunger", (some of the high--priority objectives) do not necessarily align with environmental issues but depends on political strategies and socio--cultural factors of each country. It is important to note that low performances in some goals are due to lack of data sources for countries like Equatorial Guinea. The research for this work (which is still ongoing), serves as contribution to create a beginning foundation for exchanging and improve the information needed to monitor progress in each CPLP country. This started at the 1st Conference of the CPLP in November 2015. This new foundation makes it possible not only to rank and compare countries, but also to compare how good they are actually performing on a scale from 0 to 1, as well as track and create an overview of performance over time. One of our aims is to develop a foundation for future tracking of progress for the individual countries performance in relation to each goal. This is an attempt to improve the SDG ranking by presenting an indicator that makes it possible not only to compare countries but improve the ranking by classify the variation of the country performance (0--1 scale) showing how good the countries are performing as well as their progress over time.

Keywords: Sustainable Development Goals (SDGs), CPLP, Climate Change.

1. Introduction

The emergence of the issue of climate change has sparked discussions about the relationship of humans with the natural systems, in particular with regard to the enormous intensification of this interaction in the past decades. The perception of the problems related to this intensification is expressed in the 17 Sustainable Development Goals (SDGs) translated the UN Resolution 70/1: Transforming our world: the 2030 Agenda for Sustainable Development presented in 2015 (UN General Assembly, 2015). For the implementation of this great effort "for the people, for the planet, for peace, partnership and prosperity" (SDSN, 2015), a fundamental part is the revolution of data that needs to happen so that progress can be monitored transparently and consistently. The data involved initially demands an effort to identify the best available data and critical for the availability and relevance in order to be measured the progress achieved. The availability and systematization of reliable, current and meaningful data is vital to the success of a global strategy aimed results.

This work focuses at the Community of Portuguese Language Countries (CPLP - Comunidade dos Países de Língua Portuguesa) as case of study. This work aims to show how the nine countries of the CPLP face the SDGs, analyzing the current level of compliance and fulfilling of each country in relation to the objectives.[9] The countries represent a diversity of size; geographic location and stages of economic development and can thereby present an interesting sample to describe the challenge of monitoring SDG worldwide. The countries represent four continents (Europe, America, Africa and Asia) and a variability of development stages having Portugal as a developed country, Brazil as a developing country and all other as part of the less developed countries.

The novelty of this paper is the creation of an observatory of data on SDG within the CPLP, which can contribute to the international effort of creation, validation and monitoring of data. The objective is to contribute to building a common database, reliable, appropriate and updated for monitoring country status, and in time also progress, to contribute to the Sustainable Development Solutions Network - the construction, validation and monitoring of indicators of SDG for CPLP countries and critical analysis of the data needed for the indicators of SDG in the CPLP countries.

Considering the importance of the monitoring to the global agenda strategy, this work choose the data research and analyses in a Sustainable Development Goal perspective. The SDGs are a new, universal set of goals, targets and indicators that UN member states are expected to use to frame their agendas and political policies the the next 15 years (Sachs, 2012). The SDGs follow and expand on the Millennium Development Goals (MDGs), which were agreed by governments in 2001 (UN General Assembly, 2001). The MDGs provided a focal point for governments – a framework around which they could develop policies and overseas aid programmes designed to end poverty and improve the lives of poor people, as well as a rallying point for NGOs to hold them accountable (Vandemoortele, 2009). Greater effectiveness can be achieved if the MDGs are understood as action tools because they generate discussion, focus and attention to support accountability on the promises of leaders (Clemens et al., 2007).
The idea of a set of global objectives that could collaborate to implement the sustainable

[9] CPLP is a set of countries that are linked by the language and the history and that have decided to established a community (CPLP, 1996) to reinforce the cultural bond and also economic cooperation. In 1996 were seven countries: Angola, Brazil, Cabo Verde, Mozambique, Portugal, Guinea Bissau and Sao Tomé e Principe. Today more two countries became part of the community, East Timor joined in August 2002 and Equatorial Guinea joined it in 2014.

development and also as a mean of recognizing the MDG process, in 2012, come up during United Nations Conference for Sustainable Development, the Rio+20 (UN General Assembly, 2012). The objectives of sustainable development are at the same time reaffirming the establishment of measurable objectives methodology and well defined in time on a global agenda of building "a more just and peaceful world" (UN General Assembly, 2000) and also the reassurance you can still search for a balance between economic growth, social inclusion and respect for the environment (UN General Assembly, 2015).

The MDGs specific database construction provide lessons in regard to data in the implementation of the SDGs to be effective given its complexity. The main one is that the database should be expanded, what need a data revolution (Sachs, 2015). In this topic Kroll (2015) and SDSN (2016) are two examples of the systematization of data sets to monitorize the SDGs. The first one presented an analysis of the OECD countries considering two indicator for each goal, suggest a benchmarking and a SDG-Index (Kroll, 2015). The latter (SDSN, 2016) launched a public consultation on a SDG Index Draft between 15/02/2016 and 31/03/2016, we respond on that. The methodology used in both cases are similar with the one used in this work.

2. Methods

The present study is a survey of statistical data for SDG indicators of the CPLP countries undertaken in international databases involving World Bank Data etc. (see a full list in Appendix). First step was selection of reliable and qualified indicators, which were normalized and analysed. The analysis have four aspects: a) the overall performance of the countries on all goals via an average of all normalized indicators (in weak sustainability approach); b) an analysis of economic, social and environmental sustainable performance of the countries and c) a benchmarking and d) a comparison of the achievement of countries in relation to the 13th Goal: "urgent action to combat climate change".

Three or more indicators are located and used for for each of the seventeen goals representing 2 or more of the target description for each goal. In all 64 are the foundation for the analysis The selection of indicators was based on the following criteria:

- Up to date which means data must be recent and quality for the countries of CPLP;
- Relevance, the data should be related to the monitoring indicators of global SDG’s and
- Availability, which in this study was considered that the datas must be accessible and available for all or in some cases the majority of the countries.
- Reliability, which means if the the indicator expresses what it aims to describe/measure. Here we have for instance compared several similar indicators.

Normalisation of indicators

The indicators were normalized on a scale from 0-1. The value 1 indicates 100% performance (high) and 0 indicates a performance of 0% (low). The average of the 3 or more indicators for each SDG expresses the SDG performance.

We have identified three categories of complexity, related to normalising indicators:

1. Simple indicators: percentage or indexes (from 0-100). Examples of simple indicators are: Renewable energy consumption (% of total final energy consumption) and Environmental Performance index. Both indicators have a high and a low from 0 to 100. Normalising involves dividing with 100 and you have a scale from 0-1.
2. Semi simple indicators: indicators with a limited interval different of the normal 0 to 100 and in some cases involving negative numbers. Example: ECOLOGICAL FOOTPRINT PER CAPITA (in global hectares)” is also a complex indicator to normalise, because it highest value have no roof. The indicator goes from the worst performing country Luxembourg (15.8) to the two best performing countries Timor Leste (0,5) and Eritrea (0,4). According to

the index a value of 1.7 and below is equivalent to sustainable living. *"To live within* *the means of our planet's resources, the world's Ecological Footprint would have to equal the available biocapacity per person on our planet, which is currently 1.7 global hectares."* (Global Footprint Network 2012). We have chosen 1.7 to be the lowest value (= 1) and 5 to be the highest value (= 0) to make the normalisation of this goal.

3. Complex indicators: measuring economic information and/or not closed category. Example: GDP per capita ($). We have compared with Europe & Central Asia average: $25669.7 (2014). World average was too low ($10721) to be used as an indicator. Guinea Equatorial, Portugal and Brazil have higher GDP per capita than world average).

Average of normalized indicator in weak sustainability approach

The sustainable development concept is straight related with the ecological economics that in its turn is a complex interdisciplinary approach that involves economic social and biophysical aspects. The concept of weak sustainability is described by Pearce et al as the "aggregate stock of capital intact" (Pearce et al, 1994, p. 463). This assumption that the different aspects of sustainability are somehow replaceable are linked with a economic value (Hediger, 1996, p.361). On the other hand the strong sustainability is embedded of biophysical values what means that there is no possible substitutions after the same author. Here in this work, ´weak sustainability approach´ means that all the indicators received the same weight, i.e. have the same importance or can compensate each other.

Economic, Social and Environmental Performance of CPLP countries

With the objective to identify the differences of the countries in different pillars of sustainable development, the seventeen goals were divided as economic, social and environmental one. Even considering the holistic nature of the SDG and the complexity of the linkages between them, this assortment search for possible patterns of performance, i.e. if the African countries have a better performance in social, economic or environmental indicators or if Brazil is well classified in which kind of goals. The Goals used in the economic sustainability performance are: 1 (Poverty), 2 (Hunger), 8 (Economy & decent work), 9 (Industry, Innovation & Infrastructure), 10 (Country equality) and 17 (Global partnerships). The goals used in the social sustainability performance are: 3 (Health & wellbeing), 4 (Education), 5 (Gender equality), 6 (Water), 11 (Cities & settlements) and 16 (Peaceful institutions). The goals used in the social sustainability performance are: 7 (Energy), 12 (Responsible consumption and production), 13 (Climate action), 14 (Oceans) & 15 (Biodiversity).The economic, social and environmental indicator are a result of the average of the goals chosen to represent the three

Benchmarking

Benchmarking is a process to identify the "best practices" in process, services or products (Bhutta and Huq, 1999). It was originally used in the private sector but today have a broader application. For instance Shen et al. used a benchmarking to compare the road security in a cross-national perspective. In that case the the parameters used was "setting practical targets, designing effective strategies, determining intervention priorities, monitoring programme effectiveness, and ultimately, achieving its own safety objectives". (Shen et al., 2015). Kroll used this methodology to analyse if the rich countries (OECD) are prepared to implementation of the Sustainable Development Goals (Kroll, 2015).

In this work, after this process of normalization of the indicators, the set of indicators were analysed in benchmarking perspective where the nine countries are compared with each other considering each goal. The three best positions in each goal were colored in green, the three middle positions are yellow and the three worst position are red. The objective of this kind of comparison is to have the role picture of the situation of the set of countries in the indicators chosen for the SDG monitoring process.

Climate change indicators

Looking deeper into climate change is of great importance for the success of achieving the sustainable development goals globally. Continued climate change is a grave threat to the developing world and a major obstacle to continued reduced poverty reduction across its many dimensions. On top of this the impact of climate change are not evenly distributed. The poorest countries and people will suffer earliest and most (Stern 2006).

For address this theme, this work choose four indicators to climate change in three different aspects: energy, forest and emissions. The first one was the percentile of renewable energy source used by the country, almost all non renewable energy sources are CO2 emitters except nuclear power. The second aspect was the percentile of the land of the country covered by forest due to the carbon sink role of the forests in the mitigation of climate change. The direct emissions per capita was the third aspect considered.

The fourth indicator choose was an average of two trend analyses done by Yale University considering the carbon intensity of the national economy (CO2/GDP) and the carbon intensity of the energy matrix (CO2/kWh). In the first case the period of analysis was 2002 until 2012 and in the second the time horizon was 2000 until 2012.

3. Results & Discussions

In the process of implementation the Sustainable Development Goals it is very important to identify the gap for each country and identify what is missing between the desired situation and the actual situation. This is a potentially important outcome, which can hopefully impact the public policy aims and priorities for each country and possible cooperation and support between countries according to the target for Goal 17 (UN General Assembly, 2015).

Average of normalized indicator in weak sustainability approach

The average performance of the countries in all the 17 goal in a weak sustainability approach, presented in Figure 3.1, shows the overall country performance for all indicators used in this study - the average score of the performance on all 64 indicators (after normalization). The overall picture of the CPLP country performances show that Portugal is the country with highest average performance on the indicators chosen and Equatorial Guinea is the country with lowest performance just above half of ultimate performance.

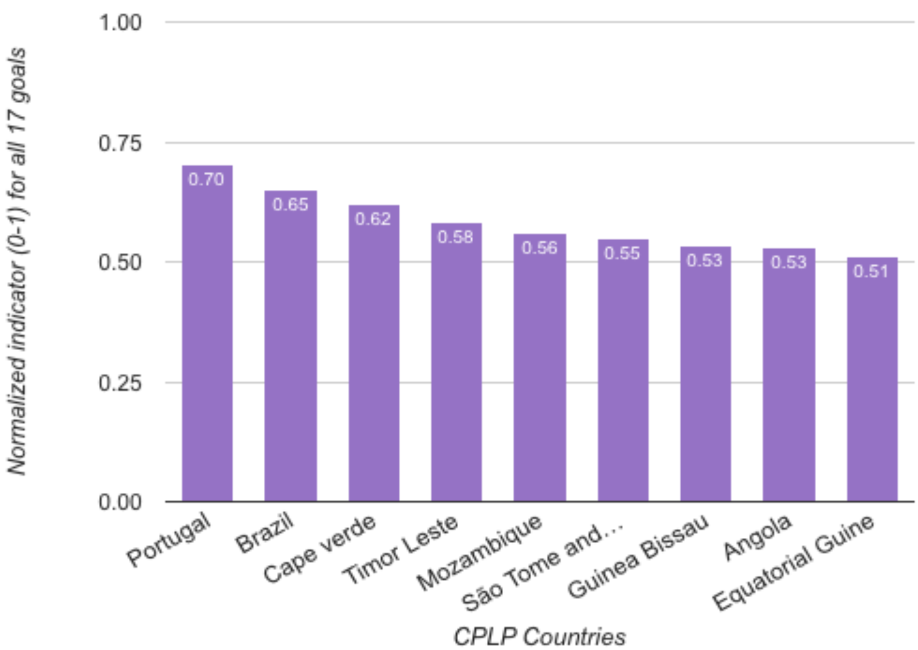

Figure 3.1: CPLP Comparison "Performance on all 17 Goals" (2016)

Portugal, Brazil and Cape Verde are the only countries performing over 0.60. While Portugal and Brazil are in top 100 of richest countries in the world they would seem to have an advantage in terms of possible investment, but Cape Verde is only the 5th best ranked of the nine CPLP countries on that list, with only São Tome, Guinea Bissau and Mozambique below (Global Finance 2015). On the other hand are Portugal and Brazil performing low in terms of climate. This is mainly due to lower investment in renewable energy and higher emissions of CO2, though Portugal is improving with a negative trend in CO2 emissions. Waste production and consume is high for both countries too which indicates less sustainable consumption. There seem to be a tendency that developed countries perform well in economic sustainability and low in environmental sustainability while the less developed economically the better the performance is in environmental indicators. The social performance seem to improve equivalent to economical development but there is no significant correlation.

The low overall performances of Timor Leste is mainly caused by three SDG's. Two economical goals on "8. Economic sustainability" and "1. End Hunger" and the social orientated goal of "16 Peaceful and inclusive societies" indicating inefficient government institutions and high degree of corruption. Equatorial Guinea, Guinea Bissau and Angola are the countries with lowest performance in goal 16, while Guinea Bissau, Angola, Sao Tome, Mozambique, Cape Verde and Equatorial Guinea are struggling with economic sustainability.

Economic, Social and Environmental Performance of CPLP countries

Economic Performance

According to the indicators we have used Timor Leste is performing good in sustainable economic development. It is not a rich country. Far from. In the list of world's richest countries Timor Leste is ranked 119 (Global Finance 2015) and 4th best of the CPLP.

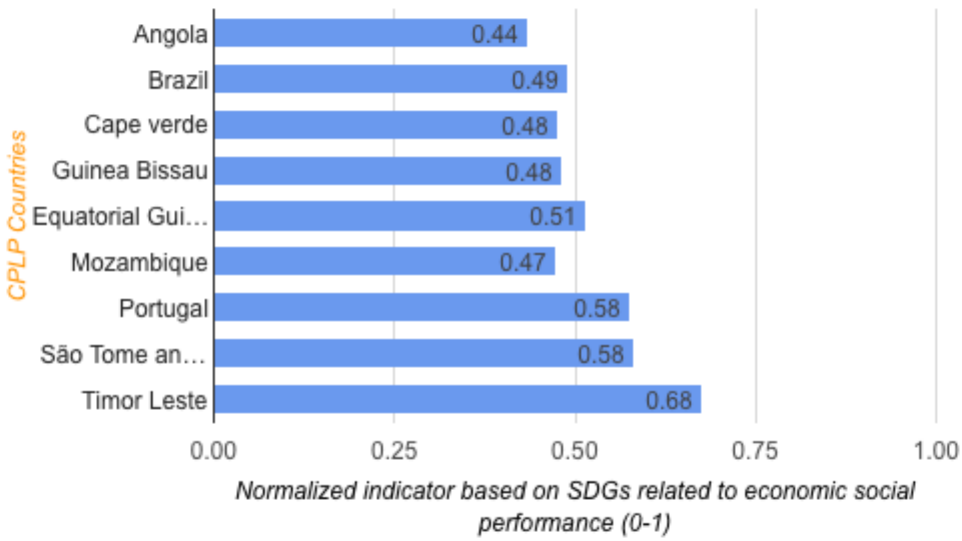

Figure 3.2: Comparison of CPLP on Economic Performance

Social Performance

Fig. 3.2 show the social performance category represented by SDG 3, 4, 5, 6, 9, 11 & 16. The analysis reveals the highest performance from Portugal, Brazil and Cape Verde.

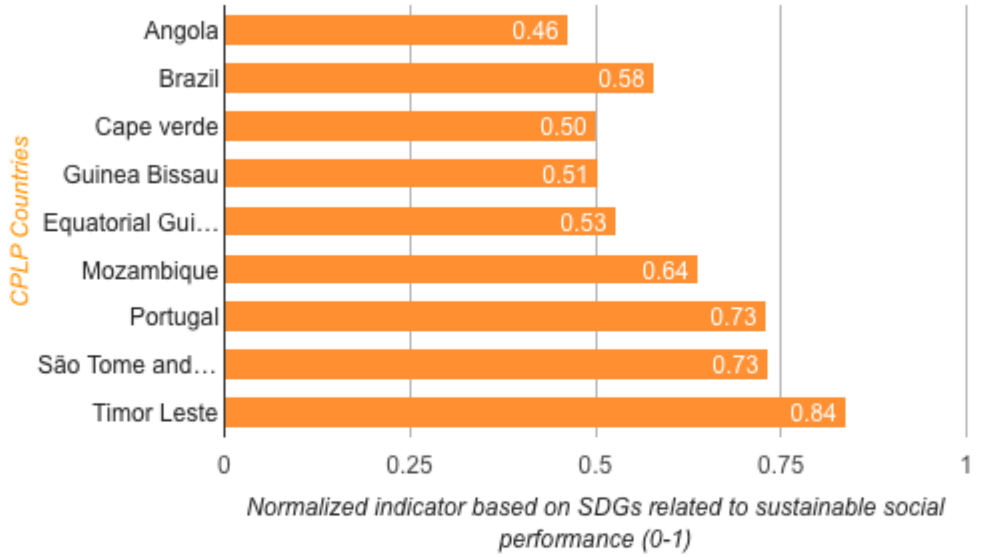

Figure 3.3: Comparison of CPLP on Social Performance.

Environmental Performance

The graphic in 3.4 reflects environmental country performance represented by SDG 7, 12, 13, 14 and 15. The highest performances was showed by Mozambique, Guinea Bissau and Timor Leste, while the lowest performance belongs to Equatorial Guinea, Cape Verde, Sao Tome and Principe and Portugal.

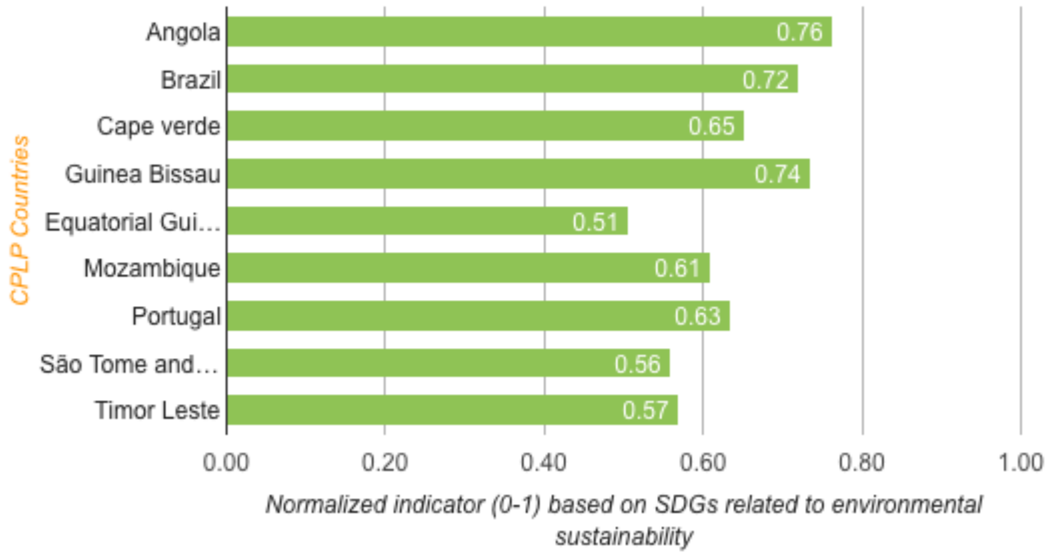

Figure 3.4: Comparison of CPLP in Environmental Performance

Mozambique is the best performer in environmental SDG's. Renewable energy and sustainable consumption or low consumption due to low economy are two important issues for this performance. Three countries have an ecological footprint below 1.0 - Angola, Mozambique and Timor Leste. An Ecological footprint below 1.7 is considered sustainable.

The CPLP have 5 member countries - including also Sao Tome and Guinea Bissau - which are considered environmentally sustainable according to the "Ecological footprint per capita" indicator. According to the total Environment measure all countries except Guinea Equatorial performs above 50%. (It is less valid to conclude the performance of Guinea Equatorial in environmental performance. It has been difficult to find environmental indicators for this country).

Again there seem to be a connection between environmental sustainability and economic growth. The three economic top performers - Portugal, Cape Verde and Brazil - struggles in providing environmental sustainability. Besides Equatorial Guinea they are the lowest countries in environmental sustainability performance.

Benchmarking

Another country comparing aspect used for the SDG performance the peer monitoring for which a benchmarking analyses can be useful. One of the basic assumptions of the SDG model is that it is possible to compare the peers because this way the monitoring process increase in consistency and legitimacy. In this process it is important to develop a picture of countries or regions. In this case, the benchmarking of all countries for all regions studied.

As seen in Figure 3.7 Brazil and Portugal are in this case often in the best positions, followed by Cabo Verde, Timor Leste and São Tomé e Principe.

Brazil has a top three positions in ten of the seventeen goals. Portugal is in the pole position in nine of the seventeen goals. At the bottom of the benchmarked countries Guinea Bissau take the worst position in nine of seventeen goals. Equatorial Guinea is the second worst performer in this kind of ranking being among the lowest three in seven of the seventeen goals. Both Mozambique and Angola are part of the lowest three in six goals. But Mozambique show a good performance in environmental indicators as discussed below. The strength in benchmarking is a quick - though complex - overview of country performance. The weakness is the difficulty to show progress over time.

Goal	Angola	Brazil	Cape Verde	Guinea-Bissau	Guinea Equa-torial	Mozam bique	Portu-gal	São Tomé & Príncipe	Timor Leste
1 Poverty	0.63	0.71	0.63	0.3	0.5	0.34	0.87	0.52	0.4
2 Hunger	0.68	0.98	0.63	0.69	0.31	0.62	1	0.68	0.66
3 Health & well-being	0.41	0.9	0.78	0.43	0.42	0.39	0.95	0.71	0.42
4 Education	0.7	0.95	0.96	0.67	0.64	0.72	0.95	0.7	0.64
5 Gender equality	0.56	0.53	0.6	0.53	0.6	0.67	0.8	0.5	0.65
6 Water	0.43	0.84	0.74	0.43	0.58	0.32	1	0.64	0.58
7 Clean energy	0.6	0.79	0.67	0.81	0.48	0.63	0.69	0.69	0.62
8 Economy & decent work	0.45	0.61	0.4	0.48	0.56	0.27	0.85	0.07	0.37
9 Industry, innovation & infra	0.13	0.33	0.18	0.09	0.24	0.17	0.29	0.11	0.3
10 Inter-country equality	0.52	0.4	0.56	0.5	0	0.54	0.43	0.66	0.69
11 Cities and settlements	0.7	0.69	0.75	0.65	0.72	0.62	0.67	0.74	0.83
12 Responsible consumption	0.36	0.41	0.28	0.35	0.02	0.45	0.26	0.33	0.34
13 Climate action	0.6	0.65	0.46	0.77	0.42	0.7	0.51	0.6	0.64
14 Biodiversity	0.67	0.78	0.57	0.54	0.79	0.79	0.67	0.51	0.9
15 Oceans	0.64	0.59	0.52	0.71	0.81	0.69	0.64	0.38	0.7
16 Peaceful & strong institutions	0.22	0.44	0.58	0.19	0.18	0.35	0.67	0.4	0.31
17 Global Partnerships	0.45	0.67	0.77	0.55	0.84	0.95	0.73	0.8	0.53

Figure 3.5 Country comparison "Benchmarking"

Country Performance by Climate - SDG 13

There are strong linkages between sustainable development and climate change. Socio-economic development has contributed to and is affecting climate change. Future scenarios predict that climate change also can affect well-being and economic development (Swart et al 2013). The CPLP countries achieving best on minimizing climate change are Guinea--Bissau and Mozambique followed by Brazil and Timor Leste. The countries performing worst on the 13th goal are Equatorial Guinea and Cape Verde followed by Portugal.

This result does not follow the trend of other indicators. Portugal which is the only developed country is performing low in combatting climate change while most of the less developed countries are high performers. However it's possible to note that issues related to economic growth, access to energy and hunger, (some of the high--priority objectives) do not necessarily align with environmental issues but depends on political strategies and socio--cultural factors of each country.

Measuring the CPLP countries and any country we still wish to measure their performance over time to show any sign of development - If and how individual countries show sustainable a positive or negative development in their yearly performance. Especially compared with a possible positive economic growth. See the four chosen indicators and individual indicator performance for goal 13 in Figure 3.6.

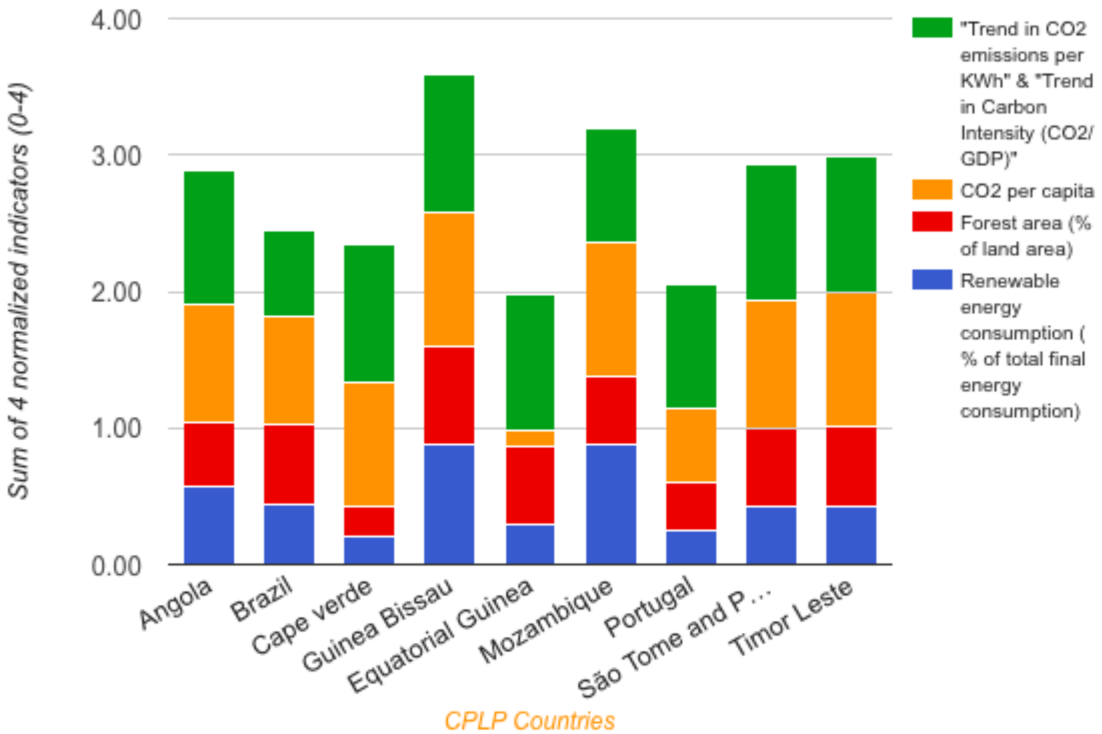

Figure 3.6: Sum of the four Indicators for SGD 13 "Climate Performance of CPLP Countries"

Looking at the four indicators it is obvious that Equatorial Guinea's bad performance in Goal 13 is due to a high CO2 emissions per capita and a lack of renewable energy sources. Big percentage of forest areas in Equatorial improves their climate performance. Portugal is performing low in renewable energy sources and percentage of forest areas. Its interesting that both Portugal and Equatorial Guinea are high performers in terms of "trend in CO2 emissions", which show that they are actually lowering their emissions and carbon intensity.

Forest areas are not part of the SGD target description for Goal 13 but we consider development of forests areas a mitigation action and the indicator "Forest area (% of land area)" we consider to be the indicator that comes closest to mitigation action in this goal. High performers here are besides Equatorial Guinea also Guinea Bissau, while Portugal and Cape Verde are the two lowest.

Combating climate change is important for the success of all goals. We believe stabilizing or lowering of greenhouse gases are influencing sustainable environmental, economic and social development. Swart et al (2013) argues that "since the feasibility of stabilising greenhouse gas concentrations is dependent on general socio-economic development paths, climate policy responses should be fully placed in the larger context of technological and socio-economic policy development". Here it would be increase reliability to include and measure methane emissions for the CPLP countries as well, but only four of the countries are tracking methane emissions. Again we emphasize the challenge of measuring developing countries in SGD performance due to lower involvement or inclusion in many statistics.

Portugal and Equatorial Guinea show low performance due to high emissions of CO2. The reason for that are very different, while Portugal has a higher GDP per capita, Equatorial Guinea is oil producer (IEA, 2014, p. 43).

5. Conclusions

Monitoring SDGs gives us an idea of the status of countries. Not necessarily the development over time. For some countries and especially Equatorial Guinea there are several indicators missing. This decreases the performance of the country, which envolves a risk of presenting a different monitoring of some countries.

The four challenges we have discovered measuring the state of CPLP countries are:

1. Finding indicators measuring small and less developed countries.
2. Evaluating the reliability of indicators available.
3. We need many different and similar indicators to embrace each SDG target to make sure the indicators embrace the SDG.
4. Finding the right combination and weighting of indicators. Some indicators are more important than others and could be emphasized by multiplying them x1,5, x2, x3 etc..

There is a connection between performance in economic and social sustainability. The three countries performing highest on economic sustainability - Portugal, Cape Verde and Brazil - are also the countries performing highest in social sustainability. On the other hand countries performing low in economic sustainability are high performers in environmental sustainability.This tendece emphasise the possibility of risks in the future. If economical growth in these countries is not followed by a sustainable social and environmental development their performance may change. Historically economic growth has led to pollution and environmental damages. There has been differences in political priorities over time. Historically economic growth has been a political priority for centuries, which has lead to social development. Environmental protection is a new and upcoming priority that has become more important to government and businesses over the last 20 years (Borowy 2014). Sustainable development expresses a long term development taking social, economic and environmental development into consideration. Globally seen it would be wise to support developing countries on environmental protection and social development side by side with economic growth, this involves promoting environmental sustainability – F.I. promote sustainable consume, waste management and recycling.

However, in present-day society, although we recognize our dependence on the earth's resources – its water, oxygen and other natural elements – perhaps we do not recognize the connection between the economy and the earth (Higgins 2013) or it still seem to be less prioritized than economic growth and human well being.

It is especially important for developed countries to share experiences, best practices and export well functioning systems to developing countries as well as invest in developing environmentally sustainable growth - renewable energy sectors etc.

The findings in this analysis reiterated the importance of keep monitoring the SDGs, the challenges that some countries still have to fulfill the SDGs agenda by 2030. Hence the call for inclusion of environmental in the national political strategies specifically climatic meters, which are direct and indirectly connected with other indicators, that give information such as economic and social performances.

Perspectives

How can SGDs be implemented? How can politicians use SDG monitoring? Monitoring of indicators and country tracking is one thing. Implementing the SDGs is another. We intend to make a follow up of this work going into a dialogue with the respective governments to see if and how SDGs can support development through policies.

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Appendix 1: Indicators & links used in the research

Goal	Indicator	Target	Link
1	Poverty headcount ratio at national poverty lines (% of population) - Poverty rate after taxi and transfers, poverty line 50% (for Portugal)	1.1	http://databank.worldbank.org/data/reports.aspx?Code=SI.POV.NAHC&id=af3ce82b&report_name=Popular_indicators&populartype=series&ispopular=yhttp://databank.worldbank.org/data/reports.aspx?Code=SI.POV.NAHC&id=af3ce82b&report_name=Popular_indicators&populartype=series&ispopular=y
1	Poverty headcount ratio at $1.90 a day (2011 PPP) (% of population)	1.1	http://data.worldbank.org/indicator/SI.POV.DDAY http://data.worldbank.org/indicator/SI.POV.DDAY
1	Firms with female participation in ownership (% of firms)	1.4	http://data.worldbank.org/indicator/IC.FRM.FEMO.ZS?page=2&display=defaulthttp://data.worldbank.org/indicator/IC.FRM.FEMO.ZS?page=2&display=default
2	Depth of the food deficit (kilocalories per person per day)	2.2	http://data.worldbank.org/indicator/SN.ITK.DFCT/countries?display=graphhttp://data.worldbank.org/indicator/SN.ITK.DFCT/countries?display=graph
2	Cereal yield (kg per hectare)	2.4	http://data.worldbank.org/indicator/AG.YLD.CREL.KGhttp://data.worldbank.org/indicator/AG.YLD.CREL.KG
2	Prevalence of undernourishment % tre years verage	2.1	http://www.fao.org/fileadmin/templates/ess/ess_test_folder/Workshops_Events/Food_Security_for_All_FEB2011/Background_paper.pdfhttp://www.fao.org/fileadmin/templates/ess/ess_test_folder/Workshops_Events/Food_Security_for_All_FEB2011/Background_paper.pdf
3	Births attended by skilled health staff (% of total)	3.1, 3.2, 3.4	http://data.worldbank.org/indicator/SH.ANM.CHLD.ZS
3	Contraceptive prevalence, any methods (% of women ages 15-49)	3.5	http://data.worldbank.org/indicator/SH.DTH.NCOM.ZS

3	Maternal mortality ratio (modeled estimate, per 100,000 live births)	**3.1**	https://www.cia.gov/library/publications/resources/the-world-factbook/rankorder/2223rank.htmlhttps://www.cia.gov/library/publications/resources/the-world-factbook/rankorder/2223rank.html
4	Literacy rate (total population age 15 and over)	**4.6**	https://www.cia.gov/library/publications/the-world-factbook/fields/2103.htmlhttps://www.cia.gov/library/publications/the-world-factbook/fields/2103.html
4	Literacy	**4.6**	
4	Net intake rate to grade 1 of primary education	**4.1**	http://data.uis.unesco.org/Index.aspx?queryid=242http://data.uis.unesco.org/Index.aspx?queryid=242
4	Difference between the literacy rate, youth male - female (% over age 15)	**4.1, 4.6**	https://www.cia.gov/library/publications/the-world-factbook/fields/2103.html
5	Proportion of seats held by women in national parliaments (%) 2015	**5.5**	http://data.worldbank.org/indicator/SG.GEN.PARL.ZS
5	CPIA gender equality rating (1=low to 6=high)	**5.c**	http://data.worldbank.org/indicator/IQ.CPA.GNDR.XQhttp://data.worldbank.org/indicator/IQ.CPA.GNDR.XQ
5	Radio of female to male labor force participation rate (%)	**5a**	http://databank.worldbank.org/data/reports.aspx?source=gender-statistics&Type=TABLE&preview=onhttp://databank.worldbank.org/data/reports.aspx?source=gender-statistics&Type=TABLE&preview=on
5	Adolescent fertility rate (births per 1,000 women ages 15-19) 2014	**5.6**	http://data.worldbank.org/indicator/SP.ADO.TFRT
6	Improved Sanitation (2015)	**6.2**	http://search.worldbank.org/all?qterm=improved+sanitation&language=EN&ophttp://search.worldbank.org/all?qterm=improved+sanitation&language=EN&op
6	Improved Water (2015)	**6.1**	http://databank.worldbank.org/data/reports.aspx?source=2&Topic=9http://databank.worldbank.org/data/reports.aspx?source=2&Topic=9
6	Unsafe sanitation (2015)	**6.2**	http://epi.yale.edu/country/guinea-bissauhttp://epi.yale.edu/country/guinea-bissau
6	Drinking Water quality (2015)	**6.3**	http://epi.yale.edu/country/guinea-bissauhttp://epi.yale.edu/country/guinea-bissau
7	Renewable energy consumption (% of total final energy consumption)	**7.2**	2012 brasil, moçambique, portugal e angola, 2011 cabo verde, guine bissau, são tomé e guine equatorial, timor 2009. World Bank
7	Per Capita Carbon Dioxide Emissions from the Consumption of Energy (Metric Tons of Carbon Dioxide per Person) 2011		https://www.eia.gov/cfapps/ipdbproject/iedindex3.cfm?tid=90&pid=45&aid=8&cid=regions&syid=2008&eyid=2012&unit=MMTCDhttps://www.eia.gov/cfapps/ipdbproject/iedindex3.cfm?tid=90

			&pid=45&aid=8&cid=regions&syid=2008&eyid=2012&unit=MMTCD
7	Access to electricity (% of population)	7.1	http://data.worldbank.org/indicator/EG.ELC.ACCS.ZS
7	Access to electricity (% of population)	7.1	http://epi.yale.edu/country/equatorial-guineahttp://epi.yale.edu/country/equatorial-guinea
8	GDP per capita (current US$)	8.1	http://data.worldbank.org/indicator/NY.GDP.PCAP.CD/countries
8	Unemployment, total (% of total labor force)Brazil 2013	8.5	http://data.worldbank.org/indicator/SL.UEM.TOTL.ZS/countries
8	GNI per capita, Atlas method (current US$) ((RNB per capita , método Atlas (US $ correntes)))	8.1, 8.4	http://data.worldbank.org/indicator/NY.GNP.PCAP.CD/countries
9	Fixed broadband subscriptions (per 100 people)	9.c	http://data.worldbank.org/indicator/IT.NET.BBND.P2http://data.worldbank.org/indicator/IT.NET.BBND.P2
9	High-technology exports % of manufactured exports (2013)	9.5	http://data.worldbank.org/indicator/TX.VAL.TECH.MF.ZShttp://data.worldbank.org/indicator/TX.VAL.TECH.MF.ZS
9	Gross fixed capital formation (%GDP)	9.2	http://data.worldbank.org/indicator/NE.GDI.FTOT.ZShttp://data.worldbank.org/indicator/NE.GDI.FTOT.ZS
10	Income share held by lowest 20%	10.1	http://data.worldbank.org/topic/povertyhttp://data.worldbank.org/topic/poverty
10	CPIA policies for social inclusion/equity cluster average (1=low to 6=high)	10.2	http://data.worldbank.org/indicator/IQ.CPA.SOCI.XQ/countries?display=defaulthttp://data.worldbank.org/indicator/IQ.CPA.SOCI.XQ/countries?display=default
10	GINI index (World Bank estimate) (0=equality), 2007-2010	10.1	http://data.worldbank.org/indicator/SI.POV.GINI?page=1http://data.worldbank.org/indicator/SI.POV.GINI?page=1
11	Improved water source, urban (% of urban population with access), 2015	11.5	http://data.worldbank.org/indicator/SH.H2O.SAFE.UR.ZS/countries?display=defaulthttp://data.worldbank.org/indicator/SH.H2O.SAFE.UR.ZS/countries?display=default
11	Logistics performance index: Quality of trade and transport-related infrastructure (1=low to 5=high), 2012	11.2	http://data.worldbank.org/indicator/LP.LPI.INFR.XQ?display=defaulthttp://data.worldbank.org/indicator/LP.LPI.INFR.XQ?display=default
11	Air Pollution (PM2.5) - % Population weighted exposure to PM2.5 (micrograms per cubic meter), 2016	11.2	http://epi.yale.edu/content/air-quality-raw-data-file
12	ECOLOGICAL FOOTPRINT PER CAPITA (in global hectares) in gha (2012)	12.1, 11.6	http://www.footprintnetwork.org/ecological_footprint_nations/ecological_per_capita.htmlhttp://www.footprintnetwork.org/ecological_footprint_nations/ecological_per_capita.html
12	Fossil Fuel Consumption	12.c	http://www.iisd.org/gsi/fossil-fuel-consumption-

	Subsidies: Total per capita (2011)		subsidies-totalhttp://www.iisd.org/gsi/fossil-fuel-consumption-subsidies-total
12	Waste generation per capita (kg/yr)	**12.5, 12.1**	http://www.atlas.d-waste.com/
12	Combustible renewables and waste (% of total energy)	**12.5**	http://data.worldbank.org/indicator/EG.USE.CRNW.ZS/countries/1W?display=defaulthttp://data.worldbank.org/indicator/EG.USE.CRNW.ZS/countries/1W?display=default
13	Renewable energy consumption (% of total final energy consumption). Timor stopped tracking in 2009, Capo Verde 2011, Eq Gui 2011, GuiB 2011	**7.2, 7.a**	http://data.worldbank.org/indicator/EG.FEC.RNEW.ZS?page=1
13	Forest area (% of land area) 2013	**13.3**	http://data.worldbank.org/indicator/AG.LND.FRST.ZS
13	co2/per capita (metric ton/ per capita)	**13**	http://search.worldbank.org/data?qterm=co2
13	"Trend in Carbon Intensity" & "Trend in CO2 emissions" in Environmental Performance Index, Yale University (2016)	**13**	http://epi.yale.edu/country-rankingshttp://epi.yale.edu/country-rankings
14	Marine Protected Areas (Biodiversity and Habitat)	**14.2**	http://epi.yale.edu/country/equatorial-guineahttp://epi.yale.edu/country/equatorial-guinea
14	Fish species, threatened	**14,4**	http://data.worldbank.org/indicator/EN.FSH.THRD.NOhttp://data.worldbank.org/indicator/EN.FSH.THRD.NO
14	Ocean Health Index	**14.1, 14.3**	http://data.oceanhealthindex.org/scores/41http://data.oceanhealthindex.org/scores/41
14	Clean waters	**14.1**	http://data.oceanhealthindex.org/scores/41http://data.oceanhealthindex.org/scores/41
14	Biodiversity	**14.a**	http://data.oceanhealthindex.org/scores/41http://data.oceanhealthindex.org/scores/41
14	Carbon Storage (Ocean Acidification etc.)	**14.3**	http://data.oceanhealthindex.org/scores/41http://data.oceanhealthindex.org/scores/41
14	Coastal Protection	**14.5**	http://data.oceanhealthindex.org/scores/41http://data.oceanhealthindex.org/scores/41
14	Fish Stocks (Fisheries)	**14.4, 14.b**	http://epi.yale.edu/country/equatorial-guineahttp://epi.yale.edu/country/equatorial-guinea
15	Forest area (% of land area) (2001-2005)	**15.1, 15.2**	http://data.worldbank.org/indicator/EN.MAM.THRD.NOhttp://data.worldbank.org/indicator/EN.MAM.THRD.NO
15	Mammal species, threatened (2011 - 2015)	**15.5**	http://data.worldbank.org/indicator/EN.MAM.THRD.NOhttp://data.worldbank.org/indicator/EN.MAM.THRD.NO
15	Tree Cover Loss (Forests)	**14.1**	http://epi.yale.edu/country/equatorial-guineahttp://epi.yale.edu/country/equatorial-guinea

15	Terrestrial Protected Areas, National Biome Weights (Biodiversity and Habitat)	**15.1, 15.2**	http://epi.yale.edu/country/equatorial-guineahttp://epi.yale.edu/country/equatorial-guinea
15	Species Protection, National (Biodiversity and Habitat)	**15.5**	http://epi.yale.edu/country/equatorial-guineahttp://epi.yale.edu/country/equatorial-guinea
16	2014 Control of corruption: estimate	**16.5**	http://databank.worldbank.org/data/reports.aspx?source=worldwide-governance-indicators#
16	2014 Government effectiveness: estimate	**16.a**	http://databank.worldbank.org/data/reports.aspx?source=worldwide-governance-indicators#
16	Corruption Perception Index	**16.5**	http://www.transparency.org/cpi2014/results
17	All goal performance - based on performance in SDG 1-16 !!	**17**	It is our own indicator based on the availability and up to data for the country on goal 1 to 16.
17	Foreign direct investment, net inflows (% of GDP) 2015 (Angola, 2014)	**17.1, 17.3, 17.5**	http://data.worldbank.org/indicator/BX.KLT.DINV.WD.GD.ZShttp://data.worldbank.org/indicator/BX.KLT.DINV.WD.GD.ZS
17	Proportion of total Developed Market Economies imports (by value) from Developing and Least Developed Countries, as compared with *Angola, Brazil, Cape Verde etc.* , admitted free of duty for All Product Categories (Excluding arms and oil) Market Access Indicators by ITC, UNCTAD and WTO (The Millennium Development Goals Goal 8)	**17**	http://www.mdg-trade.org/38.Table.aspxhttp://www.mdg-trade.org/38.Table.aspx

Sustainability@ISDRS2016: a strategy for a more sustainable event

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Abstract

International scientific conferences are an important place of debate and reunion within academia. These conferences are usually associated with significant social, economic and environmental impacts, which are related to the organisation of the event itself and travel of participants from all continents to a specific place. The International Sustainable Development Research Society (ISDRS) Conference is one of many annual meetings where researchers in academia and implementation practices link with each other. ISDRS has as main goals (i) to generate research and knowledge about sustainable development; (ii) to disseminate knowledge about sustainable development; (iii) to educate other about sustainable development; and (iv) to establish an information exchange for sustainable development. Taking into account these goals, it is clear that the organisation of the annual conference needs to represent the vision and values of the ISDRS. Consequently, since it has never been officially created, in this work it is presented a framework to build a sustainability strategy (Sustainability@ISDRS2016) for the 22nd International Sustainable Development Research Society Conference, held in Lisbon, Portugal. The main goals of Sustainability@ISDRS2016 are (i) to clarify priorities and create a simple yet effective roadmap, that shows participants that sustainability practices were planned and not only a mix of best practices; (ii) to guide stakeholders, such as participants, staff and contracted services, for best results; and (iii) to create know-how on sustainability management for future ISDRS conferences. The approach that was followed can be divided in five stages: (i) creating a Sustainability Policy; (ii) identifying the potential impacts of the event; (iii) developing practices to monitor and mitigate potential impacts; (iv) creating guidelines to implement the strategy; and (v) monitoring and reporting. A sub-committee of the Organizing Committee (OC) was created to lead this task. During all the phases, relevant stakeholders were engaged. At a first stage, a draft of Sustainability@ISDRS2016 was presented to the OC, and it was discussed how to proceed next. Secondly, a survey was constructed aimed at all members of the OC to evaluate the sustainability policy and the practices. At a third stage, a workshop was organized to validate the final list of practices, taking into account the survey results and feedback received from other stakeholders. Finally, responsibilities were allocated to other sub-committees to enhance responsibility and the potential of the strategy. The results of the strategy were the creation of three booklets (Sustainability for staff; Sustainability for contracted services; and Sustainability for delegates), the organization of trainings to keep stakeholders engaged and oriented, and the creation of a communication strategy for implementation before, during and after the event.

Keywords: Sustainability strategy, sustainability policy, sustainable event, Indicators, Practices, ISDRS.

Sustainability Assessment of two Portuguese wines

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Abstract

In this work it is performed the sustainability evaluation of two contrasting wines produced by a Portuguese wine company: a branded rosé wine and a "terroir" red wine. The evaluation includes the life cycle stages from fermentation to bottling and packaging, on a gate-to-gate approach, but also considering the transportation of grapes from the vineyard to the winery. The sustainability evaluation is based on indicators, focusing the environmental and economic dimensions of sustainability, and selected according to their relevance to the wine sector and stakeholders. The data used in the analysis and calculation of the sustainability indicators is mostly primary data gathered in the wine producing company and complemented with secondary data from literature and databases. Results of this study revealed that per 0.75 liter of wine produced, the branded and "terroir" wines have respectively, 4.17 and 4.47 MJ of energy intensity, 1.10 and 1.23 kg CO_2 eq. of carbon footprint, 4.93 and 1.58 liter of water footprint, 0.74 and 0.75 kg of material intensity, 0.02 and 0.02 kg of solid waste and 3.47 and 1.31 liter of wastewater generated. Moreover, in the reference years, the branded wine has the largest contribution to the company's global EBITDA (of 13 - 15 %) in comparison to the "terroir" wine (of 0.4 - 0.8 %).

Keywords: Life cycle, Sustainability evaluation, Sustainability indicators, Value chain, Wine

1. Introduction

Wine production is one of the oldest industries in the agri-food sector, of economic and even cultural importance for many world regions (Rugani et al., 2013) and in particular, for Portugal. As sustainability is transversal to all human activities, the wine industry has also a role to play in the path towards a more sustainable development. To better manage sustainability challenges and even create business opportunities or competitive advantages, it is fundamental to perform proper and objective sustainability assessments of activities and products, taking into account the sector specificities (Martins et al., 2007). Hence, this work aims at performing a sustainability evaluation of two Portuguese wines: a branded rosé wine and a "terroir" red wine, considering their life cycles, from grape harvesting to winemaking, bottling and packaging. The term "terroir" is used to designate a wine produced from a defined region, with known climate and soil (terrain) characteristics that affect its flavor and scent. In this case, the "terroir" wine analyzed in this work is a dry red wine that comes from a single estate vineyard in the Douro Valley of Northern Portugal and it is made from traditional Douro Wine Region grape varieties. The branded rosé wine analyzed in this work is a broad consumption wine, whose grapes are produced in different vineyards and regions of Portugal. These wines' sustainability evaluation was done based on the definition of several indicators, selected by their relevance to the wine sector and stakeholders but also, accounting for the current consensus in this area. Selected indicators, include: energy consumption, carbon footprint, water footprint, material intensity, wastewater volume, solid waste and earnings before interests, taxes, depreciation and amortization (EBITDA). Energy consumption and carbon footprint are both consensual indicators (Mata et al., 2013; Rugani et al., 2013) and are commonly used for eco-labelling of food products (Vázquez-Rowe et al., 2013). The remaining selected indicators are relevant, mainly from an environmental and economic point of view, and are more related to the specific product and processes analyzed. All indicators were calculated relatively to the functional unit of 0.75 liter of wine, which represents the capacity of most wine bottles available in the market. This study results can be used to compare performance across different wines or wine-regions, allowing to benchmark the performance of both wines, and to recognize hotspots in their production process or to identify the process steps, where possible improvements can make a significant impact on their sustainability performance.

2. Methods

2.1. Study objective

This study aims at performing a sustainability evaluation of two wines produced by a Portuguese wine company: a branded rosé wine and a "terroir" red wine. Also, it aims to establish a comparison between both wines and results published in the literature for other similar wines and to identify hotspots in their production process.

2.2. Functional unit

The functional unit selected for this work is 0.75 l, which represents the capacity of most market-available wine bottles.

2.3. Reference years for the study

The inventory analysis and data calculation presented in this work were based on typical years of wine production. In this case, three years of reference were chosen in order to minimize seasonality and climate variations among the years. Thus, for the branded wine, which is bottled immediately after fermentation, the reference years chosen are 2012, 2013 and 2014. For the "terroir" wine that needs to have a barrel and bottle aging period, for the chosen bottling years of 2012, 2013 and 2014, the fermentation occurred during 2010, 2011 and 2012 followed by an aging period during 2011, 2012 and 2013.

2.4. System boundary definition and process description

The branded wine is produced in large volume, with grapes coming from various vineyards, and the fermentation occurs in several installations, while the "terroir" wine is produced in low volume, with grapes grown in one single vineyard farmed by the wine producing company and fermentation conducted in only one winery. Figure 1 briefly represents the system boundary definition, including the wine's life cycle stages of winemaking and bottling considered for this study.

The branded wine process begins with the reception of red grapes from vineyards nearby (20 km radius) the installations where the wine will be produced. When the grapes are received, a first weighing is carried out and the probable alcohol content is estimated by refractive index measurement. On site, the reception of grapes is done in hoppers that convey them to crushers/ destemmers. The grape stalks, resulting from the destemming operation, are composted and used as fertilizer (byproduct). In one of the several production plants the grapes are not destemmed, since the stalk acts as a drainage aid, facilitating pressing and separation of the musts, and in this case the stalks are collected with the marc that is sold for distillation and production of wine spirits (byproduct). The grapes are then loaded in hoppers and conveyed through a tubular heat exchanger to lower the temperature, since the pressing must be carried out at 14 ºC, during this operation it is added 50 mg SO_2 / kg grapes that acts as antioxidant, antibacterial and antifungal. In the pressing room a first separation of the liquid / solid phases is performed. This process results in 80 % liquid (musts), which is separated by gravity. The remaining 20 % correspond to 10 % of the so-called press's wine and the other 10 % correspond to the marc. To remove suspended solids in musts a clarification is carried out by centrifugation. The clarified musts are pumped to decanting vats where they stay for 12 hours at 12 ºC and then, to fermentation tanks where yeasts are added that will convert glucose and fructose into alcohol. The fermentation process lasts for about 20 days. After fermentation the wine is centrifuged and stabilized. The wine is then stored before being shipped to bottling.

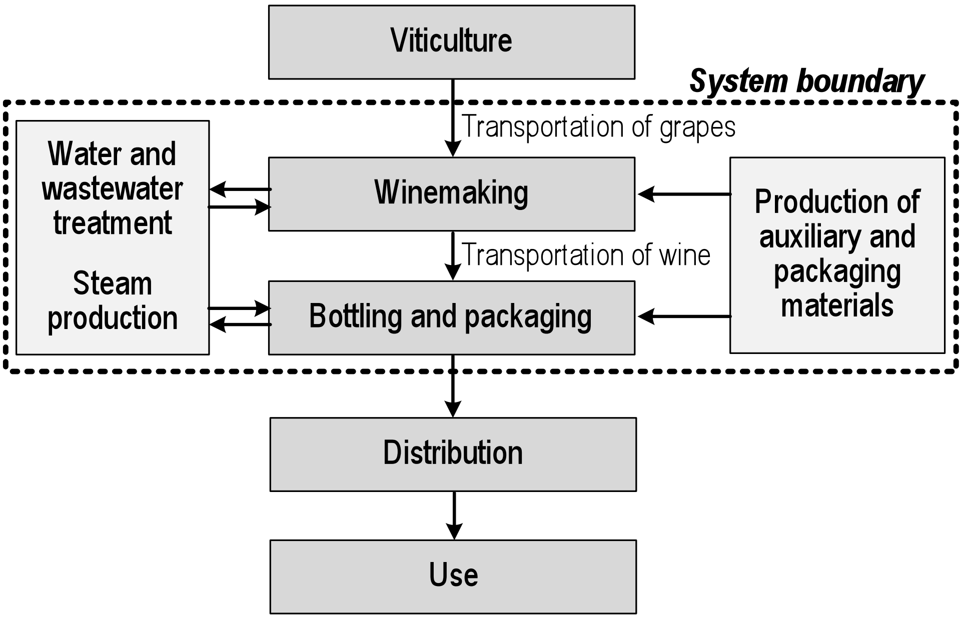


Figure 1. System boundary for the study including the wine's life cycle steps considered for the study.

For the "terroir" wine process, the grapes are harvested in the vineyards adjacent to the unit of reception and processing of grapes (winery). The vine is planted in soil with schist and is inserted into the vineyard landscape, a valley closed between mountains with a sparse vegetation typical of drylands. There is a small water stream nearby, but the region is depressed in terms of the water availability. The temperatures at the site range from about -3 °C in winter to 40 °C in summer. The grapes are registered on arrival to the winery by weight, grape variety and analysis are made to a juice sample to determine the sugar content (which gives a measure of the probable or theoretical alcohol content of the resulting wine), density, pH and total acidity. On site, the reception of grapes is done in hoppers that convey them to crushers/ destemmers. The grape stalks, resulting from the destemming operation, are composted and used as fertilizer (byproduct). The crushed grapes are sent to fermentation tanks. For fermentation oenological products (tartaric acid and yeasts) are added to the wort. Tartaric acid lowers the total acidity to pH 3.6 to 3.7. The yeast, *Saccharomyces cerevisiae*, allows to convert the sugars into alcohol. The fermentation takes about 6 days on average, after which the wine (liquid) is separated from the marc (solid) by pressing. The pressed marc is sold to produce brandy and wine spirits (byproduct). The wine produced is stored in stainless steel vats for a few days and then, it is transported in tanker trucks to warehouses (located in other installations) where it is stored in barrel for about one year of aging period before it is bottled. After the aging period the wine is transported to the bottling plant in another installation and location.

2.5. Framework for the sustainability evaluation

The framework used in this work for the sustainability evaluation can be described as a sequence of interrelated steps (Martins et al, 2007): The 1st step corresponds to the system boundary definition. Such analysis considers all life cycle stages from vine cultivation, grapes harvesting, fermentation, wine aging, wine bottling, packaging, distribution and final use. Depending on particularities of the system and study goals, different parts of the process should be considered in more or less detail. In the 2nd step, all relevant environmental, economic and societal impacts and their relative significance are determined. For the impacts identification one needs to study in detail the wine's life cycle steps and to perform a literature review. This procedure is normally supported by the identification of inputs and outputs (energy, water, materials, product, by-products, wastewater, gas emissions, and solid wastes, etc.), akin to life cycle inventory in life cycle assessment (LCA), although here not just environmental impacts but also societal and economic impacts are considered (Mata et al., 2012). With the quantitative and qualitative information gathered, an inventory is constructed to be used for computation of selected sustainability metrics. The end result is a list of indicators directly linked to the product's life cycle. In the 3rd step, indicators deemed appropriate for the system under study are selected, and prioritized based on information and data gathered in previous steps. The indicators will be used for decision making, so they need to be correctly defined and calculated to ensure that the most appropriate decisions are taken. After selection, the indicators can be quantified using data obtained as much as possible from the product or process under study. Only then, can product or process alternatives be compared, or decisions be made. This evaluation should be based as much as possible on indicators regarded as generally accepted or consensual, as it ensures that decision making is more robust and less prone to controversy. Finally, in the 4th step decisions are made for improving the product or process, based on results of all computed metrics. This framework is robust and can be applied to a wide range of products or processes (Mata et al., 2014, 2015).

2.6. Inventory analysis and data sources

The following sustainability indicators were selected to be accounted for in this study:

- Energy intensity (MJ/0.75 l)
- Carbon footprint (kg CO_2 eq. /0.75 l)
- Water footprint (L/0.75 l)
- Material intensity (kg/0.75 L)
- Solid wastes (kg/0.75 l)
- Wastewater (L/0.75 l)
- EBITDA (% of the company's global EBITDA)

The data used for the inventory analysis regarding the core processes, in particular those concerning the wine production, bottling and packaging, were gathered in the Portuguese wine producing company (primary data) and completed with literature data and data from commercial life cycle databases (secondary data).

The indicators of water footprint, material intensity, wastewater, solid waste and EBITDA were obtained using only primary data provided by the company.

For calculating the energy intensity indicator data provided by the company on the consumption of electricity and natural gas were used. To estimate fuel consumption in the transportation of grapes to fermentation and of wine to bottling secondary data from SimaProTM and average values of fuel consumption in heavy-duty vehicles in Europe were used.

In the case of the carbon footprint indicator, carbon dioxide emissions related to the consumption of electricity and natural gas were obtained directly from invoices provided by the company. For the calculation of remaining emissions secondary data obtained from databases and information available in the literature were collected. Therefore, the following data sources were used:

- Primary Data: Company bills; Data provided by the company.
- Secondary Data: SimaProTM 7.3 software; International Wine Carbon Calculator (IWCC); US Environmental Protection Agency (US EPA); other data published in the literature.

After collecting all the data and information needed for the study, they were treated and allocated to each wine under study. Then, indicators values were calculated. A comparison between both wines and with other studies available in literature was performed. A sensitivity analysis was performed for secondary data in order to assess how changes influence the calculated values.

3. Results

In this section the results of the sustainability indicators calculation will be presented for both wines. In the case of the "terroir" wine as it is matured for one year between the stages of fermentation and bottling, it is possible to consider the maturation step in the calculation of some indicators. Figure 1 shows the relative contribution of fuel and electricity use to the energy intensity of both wines.

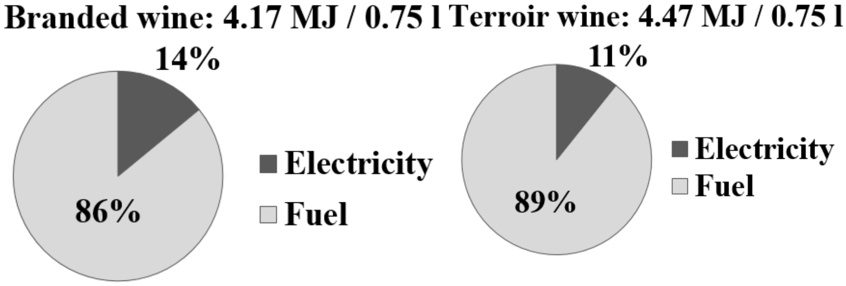


Figure 1. Relative contribution of fuel and electricity use to the energy intensity of both wines

Figure 2 shows the energy intensity of branded and “terroir” wines with the relative contributions of the winemaking and bottling steps and comparison with wines reported in literature studies.

Figure 2. Energy intensity of branded and “terroir” wines with the relative contributions of the winemaking and bottling steps and comparison with wines reported in literature: Wine 1 - white wine from Ribeiro, Spain (Vàzquez-Rowe et al., 2012); Wine 2 - white wine from the Demarcated Region of Vinho Verde, Portugal (Neto et al., 2013); Wine 3 - red wine from Tuscany, Italy (Bosco et al., 2011)

Figures 3 and 4 show the results for the carbon footprint, comparing the branded and “terroir” wines and with wines reported in literature studies.

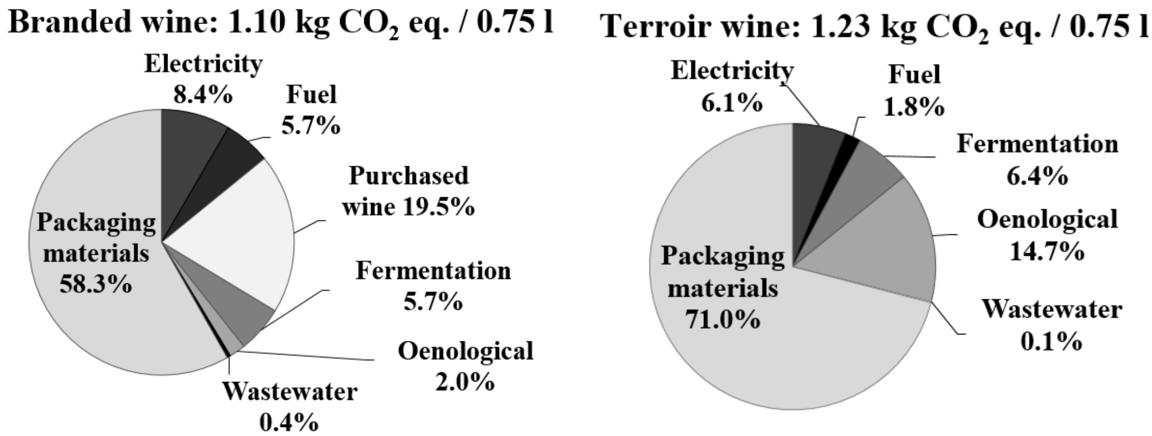


Figure 3. Carbon footprint of the branded and “terroir” wines

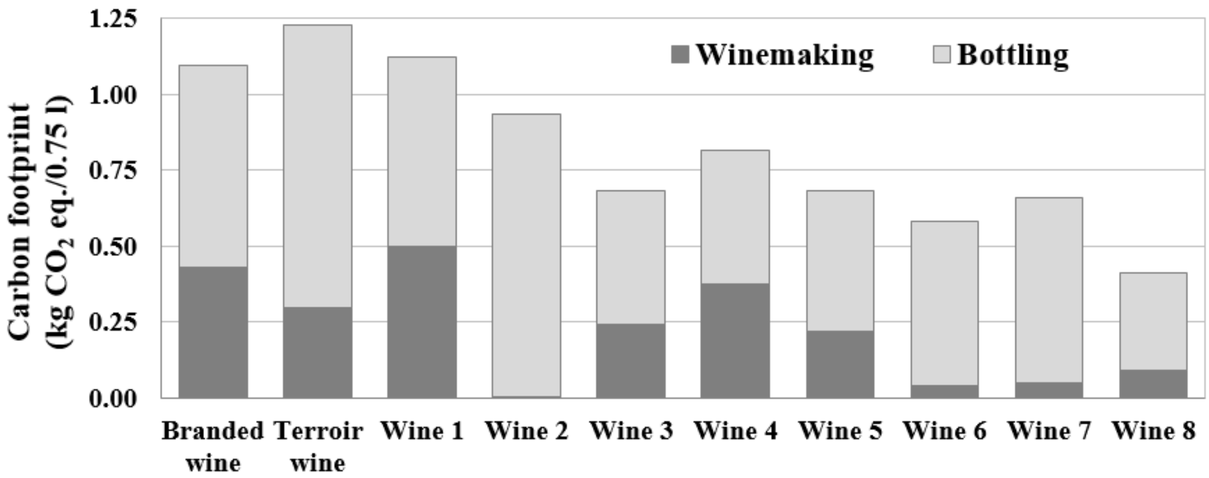
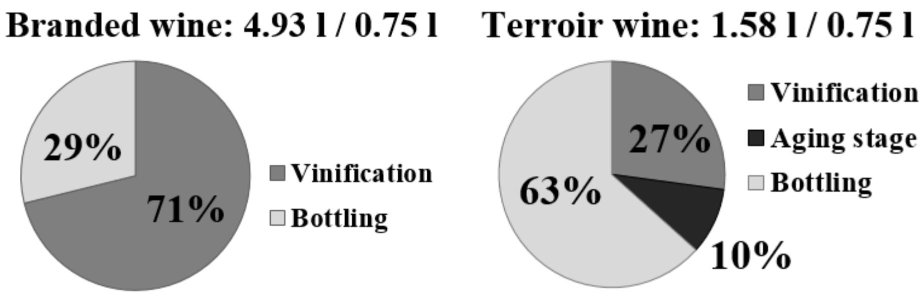


Figure 4. Carbon footprint of the branded and "terroir" wines in comparison with other wines reported in literature: Wine 1 - white wine from Ribeiro, Spain (Vàzquez-Rowe et al., 2012); Wine 2 - white wine from Sardinia, Italy (Benedetto, 2013); Wine 3 - white wine from the Demarcated Region of Vinho Verde, Portugal (Neto et al., 2013); Wine 4 - wine not specified from Canada (Point et al., 2012); Wines 5, 6 and 7 - red wines and Wine 8 - white wine from Tuscany, Italy (Bosco et al., 2011)

Figures 6, 7, 8 and 9 show the results for the water footprint, material intensity, solid waste and wastewater respectively, comNparing both wines: the branded and the "terroir" wine.



(a)

(b)

Figure 6. Water footprint of the branded and "terroir" wines for the life cycle stages of winemaking, aging period and bottling: (a) in terms of their relative percentages and (b) in terms of their total water consumption.

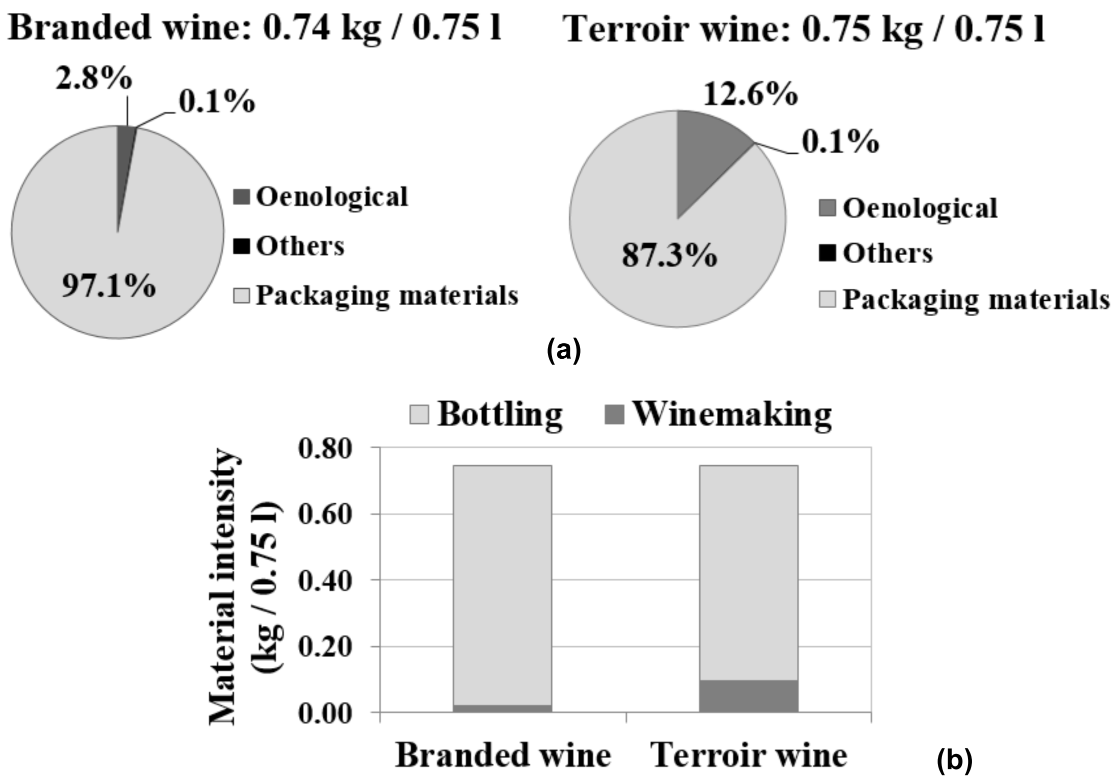


Figure 7. Material intensity of the branded and "terroir" wines per type of material: (a) in terms of relative percentages and (b) in terms of the total material consumption per life cycle stage.

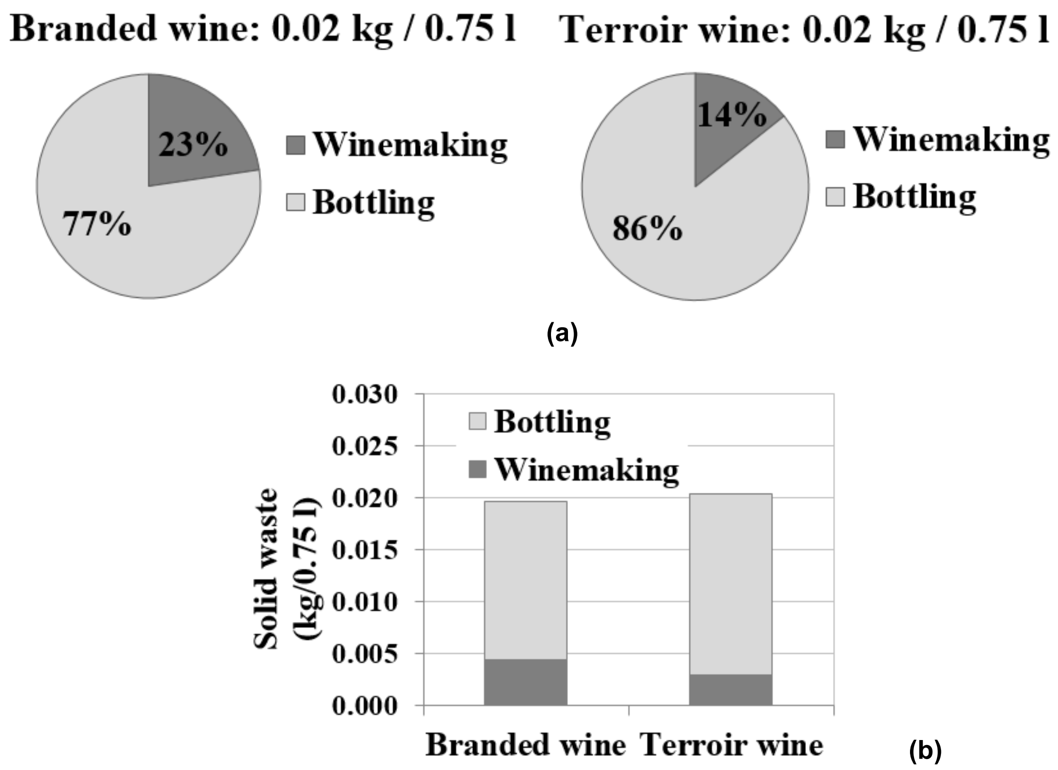
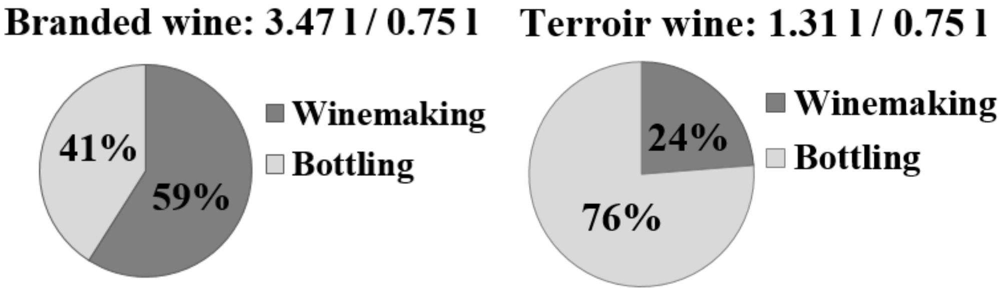


Figure 8. Solid waste generated in the production of the branded and "terroir" wines considering the life cycle stages of winemaking and bottling: (a) in terms of their relative percentages and (b) in terms of the total waste generated.



(a)

(b)

Figure 9. Wastewater generated in the production process of the branded and “terroir” wines for the life cycle stages of winemaking and bottling: (a) in terms of their relative percentages and (b) in terms of their total wastewater generated.

Table 1 shows the contribution of both wines to the company’s global EBITDA.

Table 1. Contribution of the branded and “terroir” wine to the company’s global EBITDA

Year	Branded wine	“Terroir” wine
2012	13 %	0.4 %
2013	14 %	0.7 %
2014	15 %	0.8 %

4. Discussion

In this section the results of the sustainability indicators calculation will be discussed for both wines.

Results of this study revealed that per 0.75 liter of wine produced, the branded and “terroir” wines have respectively, 4.17 and 4.47 MJ of energy intensity. This indicator includes the use of electricity in the winemaking and bottling steps, diesel use for the transportation of grapes in trucks and agriculture tractors and transportation of wine in tankers and natural gas use in stationary combustion units (boilers) for producing steam for bottles cleaning and sterilization.

Fuel use has the highest contribution to the energy intensity indicator of respectively 86 and 89 % in the branded and “terroir” wine processes (the remaining is electricity). The vineyard dispersion in the branded wine and the steep landscape where the vines of “terroir” wine are planted, with mountain and rural roads of difficult access, together with the distance between winery, warehouse and bottling installations, contribute to a higher fuel consumption in transportation. The external transportation of grapes and wine considered in this indicator includes: (1) transportation of grapes from the vineyard to the winery (several trips are performed with an average distance of 19 and 2 km respectively for the branded and “terroir” wine); (2) transportation of “terroir” wine to warehouses for maturation and then bottling (several trips are performed with an average distance of 230 km). The aging period of the “terroir” wine occurs in the same installation where it is bottled; and (3) transportation of the branded wine to the bottling plant (several trips are performed with an average distance of 149 km).

The comparison with other published wine-related LCA studies cannot be done directly due to differences in system boundary definitions and assumptions that explains the variability on the energy intensity indicator among studies. For example, in this study the external transportation of grapes and wine is accounted as part of the winemaking step. In other studies, external transportation is not accounted for (Vàzquez-Rowe et al., 2012) or it is accounted as part of other life cycle steps, such as grape production or viticulture (Neto et al., 2013; Bosco et al., 2011).

The white wine from Ribeiro, Spain (Vàzquez-Rowe et al., 2012) reports an energy intensity of 3.881 MJ/0.75 l, due to electricity and propane consumption in the winemaking and bottling steps together. This value compares well with the energy intensity of the wines in this study, although fuel use in transportation is not considered, which would increase it.

The Portuguese white wine from the Demarcated Region of Vinho Verde (Neto et al., 2013) reports an energy consumption of 1.48 MJ/0.75 l for the winemaking and bottling steps together, due to electricity and liquid petroleum gas (LPG) consumption in the factory site. Again, fuel consumption in the external transportation of grapes or must is not accounted as part of these steps, which would increase this energy value.

The red wine from Maremma rural district in Tuscany (Bosco et al., 2011) reports an energy consumption of 1.26 MJ/0.75 l due to electricity and diesel consumption in the winemaking, bottling and packaging steps, but do not considers the fuel consumption in the external transportation of grapes to the factory site.

The carbon footprint of the branded and "terroir" wines are respectively, 1.10 and 1.23 kg CO_2 eq./ 0.75 liter. The emissions contributing to carbon footprint in this study are those associated with the production of electricity, fuel consumption, fermentation of wine, the transportation of purchased wine (IWCC, 2016), production of oenological products, wastewater treatment and packaging materials.

This carbon footprint value of the branded wine in this study compares well with the white wine from Ribeiro (Spain), with a carbon footprint of 1.07 kg CO_2 eq./ 0.75 liter (Vàzquez-Rowe et al., 2012). This author also considers the production of glass bottles in this indicator but do not accounts with the production of other packaging and auxiliary materials.

Other authors reported values for the carbon footprint, between 0.41 and 0.93 kg CO_2 eq./ 0.75 liter (Benedetto, 2013; Neto et al., 2013; Point et al., 2012; Bosco et al., 2011), due to different assumptions and steps considered within the system boundary. For example, Neto et al. (2013) report a value of 0.68 kg CO2 eq./ 0.75 liter but do not accounts emissions from the production of packaging materials such as cork stoppers and labelling materials used in the bottles, wastewater treatment and emissions associated with the production of electricity and fuel consumption in the transportation of wine and must.

The production of packaging materials contributes 58.3 and 71.0 % to the carbon footprint of the branded and "terroir" wines, respectively. Among the different literature studies, bottling is in general the life cycle step with the highest contribution to carbon footprint, mainly due to the production of glass bottles (with large CO_2 emissions from the glass furnace) and other packaging materials such as tin capsules (Vàzquez-Rowe et al., 2012; Benedetto, 2013; Neto et al., 2013; Point et al., 2012; Bosco et al., 2011).

The water footprint of the branded and "terroir" wines are respectively, 4.93 and 1.58 liter of water/ 0.75 liter. The water footprint of the branded wine is more than double that of the "terroir" wine. This is explained by the differences in the winemaking step of both wines. In the branded wine, the winemaking includes a desulfitation operation that consumes large quantities of water (about 66 % of the water consumption in the winemaking step) that doesn't exist in the "terroir" wine process. Moreover, the branded wine is produced in several installations in different locations, which contributes to a higher volume of water for the washing of equipment of the different facilities. The winemaking of the "terroir" wine is a seasonal activity and is located in just one place and installation, resulting in a lower water consumption for the washing of equipment. Also, the bottling step of the branded wine consumes more water than that of the “terroir” wine. This is because of the constant operation, throughout the year, of the bottling plant of the branded wine, which consumes large volumes of water in the bottles rinsing operation.

The material intensity of the branded and “terroir” wines are respectively, 0.74 and 0.75 kg/ 0.75 liter. Bottling is the life cycle step with the largest material intensity, mainly due to the consumption of packaging materials (particularly glass bottles) with a relative contribution to this indicator of 97.1 and 87.3 % respectively in the branded and “terroir” wines.

The solid waste of the branded and “terroir” wines are respectively, 0.02 and 0.02 kg/ 0.75 liter. Bottling is the step with the largest amount of solid waste generated, mainly packaging materials such as paper, cardboard, plastic and glass.

The wastewater of the branded and “terroir” wines are respectively, 3.47 and 1.31 liter/ 0.75 liter. Bottling is the life cycle step with the largest generation of wastewater for both wines. The wastewater associated with the branded wine is larger than that of the “terroir” wine, since the water consumption is also larger and various installations are involved in the winemaking of the first one.

The branded wine has the largest contribution (13 - 15 %) to the company’s global EBITDA in comparison to the “terroir” wine (that corresponds to just 0.4 - 0.8 %) in the reference years, as the produced volume is also vastly superior. However, the “terroir” wine registered the largest growth in terms of contribution to the company’s EBITDA, corresponding to 49 and 11 % of growth in 2013 and 2014, respectively. In contrast, the branded wine recorded a lower increase of 21 and 2 % in 2013 and 2014, respectively. This is in line with the recent increase in awareness and value perception of wines produced with a sense of origin. In the case of our example, the “terroir” wine being from the Douro Valley, further explains the verified increase as Douro red wines have in recently shown a strong trend for value recognition in international markets (Wine Spectator Top 100, 2015). This fact means that greater margin from this type of wines may be available for investment into the other pillars of sustainability (environmental, social, cultural).

Possible measures to minimize environmental impacts include the reduction of water and energy consumption to be implemented after specific water and energy audits, which are already ongoing at the time of this publication. There is also the possibility to reduce the weight of glass bottles and card boxes or to replace some packaging materials by others with less environmental impact, namely the tin capsules of the “terroir” wine’s bottles by aluminum capsules. This measure would reduce the packaging materials from 36 % to 5 % and the respective carbon footprint from 1.23 to 0.94 kg CO_2 eq./ 0.75 L. Another measure to reduce the carbon footprint would be the use of a PET- polyethylene terephthalate bottle, substituting the conventional glass bottle. However, the distribution of wine in plastic bottles is not always well received by consumers. In previous commercial experiments, the use of lighter glass bottles and of aluminum capsules was pointed out as aspects that contributed to lower the acceptance of the “terroir” wine by consumers, which means that its use must be very carefully introduced and accompanied by the necessary marketing campaign. This lower acceptance was tied with an increase in the probability of accidents for lighter bottle breakage and flesh cuts from aluminum capsules thus decreasing the social sustainability of these options.

5. Conclusions

This study evaluated the sustainability of two Portuguese wines: a branded rosé wine and a “terroir” red wine, focusing on chosen environmental and economic indicators. It is concluded that for both wines, winemaking is the life cycle step with the highest energy intensity mainly due to fuel consumption in transportation and stationary combustion units. Bottling is the life cycle step with the highest carbon footprint, mainly due to the emissions associated with glass bottles production. The water footprint of the branded wine is more than double that of the “terroir” wine, mainly due to the wine desulfitation process and the constant operation of its bottling plant that consumes large volumes of water in the bottles rinsing operation. For the same reasons, the wastewater of the branded wine is more than double that of the "terroir" wine. For both wines, bottling has the largest contribution to material intensity mainly due to the glass bottles weight and to the solid waste mainly due to residues of packaging materials. The branded wine has the largest contribution to the company's global EBITDA but the "terroir" wine registered the largest growth.

The results of this work will allow the company to better streamline its production chain in order to increase its global sustainability, while aggregating value for all involved stakeholders, most especially the final consumer.

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An assessment model for government environmental education programs and projects

Claudia Pocho, Tomás Ramos, Carlos Frederico Loureiro, and Elton Fernandes

Abstract

Sustainability and environmental policies, plans, programs, projects and practices should be continuously monitored and evaluated, in order to follow-up the effective outputs and outcomes, including medium and long term effects. Environmental education programs, projects and related initiatives are examples of those instruments that need an effective follow-up stage process to evaluate their performance at individual, organizational and sectorial levels. Despite the existence of relevant work on the development and implementation of environmental education programs and projects, there is a lack of research on approaches and frameworks that support the monitoring and evaluation of the education performance. The main aim of this research is to develop an assessment model for governmental environmental education programs, to support their monitoring and evaluation stage. This model was grounded on an assessment systems approach, designed to provide accuracy and objectivity, and be supported by a participatory scheme that includes policy makers, environmental education practitioners and public officers. Integrating both qualitative and non-qualitative evaluation approaches, the proposed model is based upon an assessment system that includes a systemic set of indicators as a result of a hierarchical array of expected results. The indicator set is structured based on overall and specific guidelines, to evaluate the efficiency and effectiveness of governmental environmental programs, including how the general and specific goals and targets are achieved. The evaluation model assumes that environmental education programs must contribute to the construction of a culturally diverse, ecologically balanced, socially fair and politically active society. The proposed evaluation model also incorporates detailed environmental education criteria for supporting the assessments, according to the best practices in the educational area. Finally, for each indicator there are a set of questions that must be answered by the evaluator in order to conclude and complement the final value of each indicator. The model provides a systematic evaluation tool that integrates assessment procedures and establishes self-assessment basis to support continuous follow-up and learning, through monitoring and evaluation of environmental education programs. It could also contribute to guide and improve the planning, development and implementation stages of an environmental education program. This model has been implemented for assessing environmental education programs from the energy sector in Brazil. The assessment model demonstrated that could be applicable and suitable for supporting the assessment of these programs, and provide valuable information for decision-making processes, in particular when reviewing program performance and redefining new aims and targets.

Keywords: environmental, education program and project, performance assessment, monitoring, indicators

The social dimension of sustainable development in organization: evaluation using mixed methods

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Abstract

The number of organizations putting issue of sustainability on strategic agenda has been growing in the past few years. Even triple bottom line is on the agenda of sustainability; however, the content and evaluation of social dimension of sustainable development is still challenging for organizations. Environmental and economic dimensions could be more easily evaluated by clearly expressed quantitative indicators. Meanwhile, social dimension requires more discussion and consensus among organizations stakeholders. Equally important for organizations is to ensure that their social dimension of sustainable development identity is appropriately portrayed to their audiences. Despite the growing interest of researchers on sustainable development of organizations, the social dimension of the construct still lacks the conceptual maturity and empirical research. Obviously top managers play key role in sustainable development of organizations; however, equally important is how employees experience and recognize sustainability in their daily work activities and how sustainability issues are appropriately communicated to other stakeholders in public available information sources. This paper aims to ground the use of mix method for evaluating the social dimension of sustainable development in organization. The evaluation of social dimension of sustainability requires the qualitative approach and integration of different research methods. This paper grounds the use of mixed methods investigating how social dimension of sustainable development is expressed by top management, perceived by employees and communicated for public. For reaching the aim of paper three methods are applied: the interview of top managers, the survey or semi structured interview of employees (depends on the size of organization) and content analysis of organization web page. Thus, method triangulation is used. Pre-study is conducted in service sector organization, the member of Lithuanian social responsible business association.

Keywords: Social dimension of sustainable development, Mixed method, Evaluation, Sustainable development in organization

1. Introduction

The challenges as globalization, climate changes, depletion of resources and aging population determine that society's development can no longer take the direction of economic quantitative growth; there is a necessity for qualitative changes. Sustainable development is treated as a relevant alternative to neoliberal economics (Lozano and Huisingh, 2011) and is described as "meeting the needs of the present without compromising the ability of future generations to meet their needs" (World Commission on Environment and Development, 1987). The commitment to sustainability is growing on societal and business levels; from local to international scale: the efforts of the United Nations are reflected in legal acts as Agenda 21; in the case of Switzerland sustainability is constitutional goal (Dyllick and Hockerts, 2002); sustainability issues are on the strategic management agenda of many organizations (Taylor, Osland and Egri, 2012). Notwithstanding the contribution to understand the sustainability not only intuitively (Briassoulis, 2001), one of the fundamental challenges is to make the construct operational, to express it in concrete, operational terms (Labuschange, Brent and van Erck, 2005; Hutchins and Sutherland, 2008). Striving to use sustainability to guide decisions on organizational level, three aspects have to be taken into consideration: the pluridimensional nature (Lehtonen, 2004), the wide range of stakeholders and the evaluation process.

Generally sustainability addresses three dimensions (economic, social and environmental), while some authors include institutional dimension, as introduced by the United Nations approach (Labuschange et al., 2005). The essence of sustainability "lies precisely at the interfaces and trade-offs between the often conflicting objectives of economic and social development, and environmental protection" (Lehtonen, 2004, p.200), but requires the sustainability of each dimension. Despite the anthropocentric focus of sustainability (Dempsey et al., 2011), it is common practice to address economic pillar or environmental pillar of sustainability, whereas the social dimension receives less appreciation (Lehtonen, 2004; Hutchins and Sutherland, 2008). One of the reasons why social sustainability seems to be very challenging is related to the nature of dimension: social sustainability is based on multi-faceted social values, which are influenced by different stakeholders (Almahmound and Doloi, 2015). Hereby, when tackling social sustainability in a multi-stakeholder environment, the issue becomes the achievement of coherence in stakeholders' understanding (evaluation). This means that the integration of the stakeholders' interest in the evaluation of social sustainability of organization is of the high importance.

The diversity of the guidelines and the frameworks proposed to assess the sustainability, also social sustainability, means no clear consensus on the measure tools (Almahmoud and Doloi, 2015). After the analysis of different evaluation frameworks the paper suggests evaluation model with summarised characteristics. As the paper highlights the stakeholders' interests, the mixed method approach that integrates qualitative and quantitative methods for evaluation is proposed. This allows to answer the main research question – how to disclose the coherence of expression of the social sustainability of organization from qualitative and quantitative perspectives? The pre-study results reveal relevancy for further research and practice. The reason to use grounded mix method evaluation model for further research is based on statistical and communicative validation of proposed research instruments.

Concept of Social Sustainability and Overview of Relevant Indicators

According to Lehtonen (2004) "the social dimension has commonly been recognised as the weakest "pillar" of sustainable development, notably it comes to its analytical and theoretical underpinnings" (p. 199-200). Hutchins and Sutherland (2008) stress that until recently social sustainability has not been well-defined. The same attitude is shared by Boström (2012) who emphasizes challenging aspects of the social dimension. The question is why different dimensions of sustainability have not been equally prioritised within the construct. A primary reason of such imbalance is that current construct of sustainability has evolved from a synthesis of the 1960s environmental movement and the 1970s basic needs approach to economic development (Landorf, 2011). An additional reason is related to measurement practice - economic and environmental arguments which are based on methods, such as cost–benefit analysis and environmental impact assessment (Landorf, 2011), whereas social sustainability cannot be addresses with the same analytical tools as the economic or environmental sustainability (Lehtonen, 2004).

As mentioned above, the social sustainability presents the facet of sustainability that is most difficult to define (Lehtonen, 2004; Hutchins and Sutherland, 2008; Almahmound and Doloi, 2015). Unlike the other sustainability dimensions, the social dimension includes greater proportion of subjective factors (Edum-Fotwe and Price, 2009); the social sustainability "framing" is generally considered to be diffuse and subjective (Boström, 2012); social sustainability is bipolar (it refers to individual and collective levels), reflexive and immaterial (Lehtonen, 2004); many social sustainability concepts may remain implicit as they are somewhat concealed behind a seemingly random choice of common socio-political indicators (Littig and Griessler, 2005); the broad and multi-faceted connotation of the word 'social' has an analytical as well as a normative meaning (Littig and Griessler, 2005).

Definitional diversity reveals the differences in the content and in the context of social sustainability. According to McKenzie (2004), social sustainability is "a positive condition within communities, and a process within communities that can achieve that condition" (p.23).

Labuschagne et al. (2005) argue that social dimension is concerned with the organization's impact on the social systems in which it operates, as well as the organization's relationship with its various stakeholders. As stated by Rojak and Vinodh (2015), social sustainability is how communities, societies and individuals live; it is about basic needs and equity. Bramley et al. (2009) propose that social sustainability should be seen as comprising two dimensions: social equity and sustainability of community. The literature review, made by Landorf (2011), reveals that basic needs and equity are consistently evident as fundamental themes of social sustainability. Hereby, social sustainability is based on nature of the human beings - both concepts (basic needs and equity) are necessary for the physical and psychological survival of individuals. As commonly accepted definition of social sustainability is not available, what defines the social is determined by the underlying frameworks (Lehtonen, 2004).

The literature provides wide spectrum of integrated sustainability frameworks (Parris and Kates, 2003) or frameworks for assessing only social sustainability (Labuschagne et al., 2005). Besides the frameworks, some approaches that seem to be in line with social sustainability are provided (Lehtonen, 2004: Nikolaou, Evangelinos and Allan, 2013). For example, Lehtonen (2004) analyses social sustainability addressing capacity approach and social capital approach. Hutchins and Sutherland (2008) display the four fundamental flows (physical substances, human resources, information and financial resources) into and out of organization and consider how these flows could be used for social life cycle assessment. Nikolaou et al. (2013) apply reverse logistics for sustainability assessment based on Global Report Initiative framework.

The meta-analysis in sustainability assessment field confirms no consensus regarding the assessment of social sustainability. Parris and Kates (2003) reviewed twelve efforts to characterize and measure sustainability and draw a conclusion that there are no indicator sets that are universally accepted due to three major reasons: the ambiguity of sustainability; the plurality of purpose in characterizing and measuring sustainability; and the confusion of terminology, data and methods of measurement. Singh et al. (2009) discuss sustainability indicators, offer guidelines for construction of indices and provide description of twelve sustainability indices clusters, including Development indices and, Social and quality of live-based indices. The Compendium of Sustainable Development Indicator Initiatives, made by International Institute for Sustainable Development (IISD), lists over 500 sustainability indicator efforts. According to Littig and Griessler (2005), the indicators are frequently founded on a practical understanding of plausibility and political agendas rather than on theory and empirical evidence.

Table 1 presents a comparison of the main integrated sustainability and only social sustainability evaluation frameworks. The aim is not to review all frameworks that are available to measure overall business sustainability or social sustainability. Indeed, the aim is to provide frameworks which are appropriate to evaluate social sustainability on organization level and allows validating the model provided in the paper.

Table 1. The frameworks of sustainability evaluation.

Framework	Brief description	Advantages	Disadvantages		Structur
Global Report Initiative	Based on "triple bottom line" approach; Hierarchical framework consists of categories, aspects and indicators; Voluntary character;	Globally accepted reporting guidelines (Nikolaou et al., 2013; Lozano and Huisingh, 2011); Appropriate for each	Too much indicators, not all indicators are easy to evaluate (Labuschange et al., 2005; Lozano	Social dimension structure	Employr Occupati Educatio Equal F Supplie Labor

				Labour practices and decent work	Investm Associa Labor / F Practice Supplier F
				Human rights	Local C Poli Complian on Sc
				Society	Custon Service L
United Nations Commission on Sustainable Development framework	Based on four sustainability dimensions; The emphasis is on policy-orientated topics to better serve policy decision-making needs; Hierarchical framework consists of themes, subthemes and indicators; Qualitative and quantitative indicators	Includes institutional aspect of sustainability (Labuschange et al., 2005)	Not all aspect are relevant to business community (Labuschange et al., 2005); Majority of the social indicators are subjective and qualitative; Descriptions of corporate activities are informative; It is problematic to incorporate qualitative data into the decision-making tools (Hutchinsinson and Sutherland, 2008)	Product responsibility Equity Health Education Housing Security	Nutriti Del
Labuschange et al. (2005) Brent and Labuschange (2006)	Based on "triple bottom line" approach; Incorporates criteria from a number of key frameworks; Social sustainability is based on the criteria from supplemental guidelines	Measures the sustainability of operations within the process industry (Singh et al., 2009); Applicable to asses sustainability	Less complex and impact oriented, as well as strongly favours environmental aspects; The clear set of	Internal human External population Stakeholder participation	Employm Health Human ca Informat

				Macro social performance	Soci
Almahmound and Doloi (2015)	Incorporates only social sustainability; Applicable to asses social sustainability of projects in particular (construction) industry	The stakeholders interest-based approach; Based on social network analysis	Applicable for particular (construction) industry	Capital performance	Prov oppor mater
				Health and physical comfort	Reduci waste pr utilisa Contro hygie
				Accessibility	The prov paths ar the pr amenitie develo
				Integration	Engagin construc with educ develop socia historic
				Usability	Meeting Safe and provi equipme
				Psychological comfort	Provision and grou control c Satis stakeho privileg recognisi
				Operation health and safety	The pro worker safely quality m and hear Enhanci among
Hutchins and Sutherland (2008)	Incorporates only social sustainability; Applicable to asses social sustainability of supply chain / Indicators are quantifiable and information is generally available from organization reports	Indicators address a spectrum of human and social needs from basic to higher order	Four indicators do not completely cover all aspects of social sustainability	Labour equity	Distributi
				Healthcare	Support
				Safety	The sa
				Philanthropy	

As it is seen in Table 1, the frameworks contain different social dimension structure and suggest different evaluation approaches: qualitative or quantifiable indicators, or index. Most frameworks underline quantitative approach and sustainability index calculation. Striving for more qualitative analysis of the social dimension of sustainability, the following characteristics are proposed:

internal stakeholders' responsibility, external stakeholders' responsibility and product responsibility.

- *Internal stakeholders' responsibility (employees orientation)* – it is desirable to establish some evaluation criteria that describe the organization role in providing / supporting employee participation in organization decisions making, employee cooperation, equal opportunities, employee competencies development and health and safe work environment.
- *External stakeholders' responsibility (society orientation)* – the organization plays the important roles within a community and the whole society, which is not related to its main functions as a business. Some evaluation criteria as regards to external partnership, social activities and corporate profile provided for stakeholders are presented.
- *Product responsibility (customer orientation)* includes awards and achievements; customers satisfaction and compliance; use of safe, innovative and green technologies; quality and environmental management system.

2. Methods

A mixed methods approach with qualitative and quantitative data collection techniques was used to gain a holistic understanding of stakeholders' perceptions of social dimension of sustainable development of organization. A mixed methods research design is a procedure for collecting, analysing, and "mixing" both quantitative and qualitative methods in a single study or a series of studies to understand a research problem (Clark and Creswell, 2011). The basic assumption is that the uses of both quantitative and qualitative methods, in combination, provide a better understanding of the research problem and question than either method by itself (Creswell, 2013). In this research quantitative and qualitative data were collected separately in three phases so that data from one source could enhance, elaborate or complement data from the other source (Miles and Huberman, 1994). Additionally, the data were collected from multiple levels in an organization, such as the managers and employees (see Fig 1).

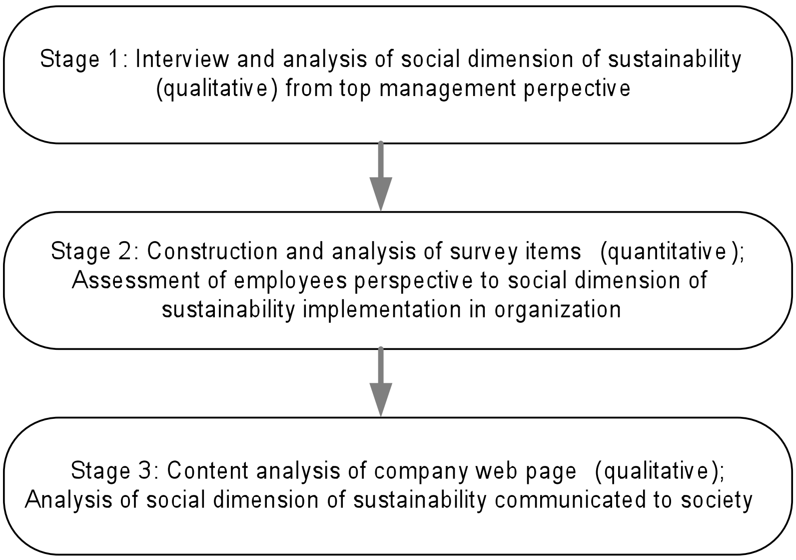

Figure 1. Mixed methods approach to evaluation of social dimension of sustainability.

Assessing the social dimension of sustainable development of organization two questions ought to be answered: which characteristics, criteria and indicators should be considered, and the issue of data availability and complexity (Hutchins and Sutherland, 2008). The indicators of provided characteristics are presented in Figure 2.

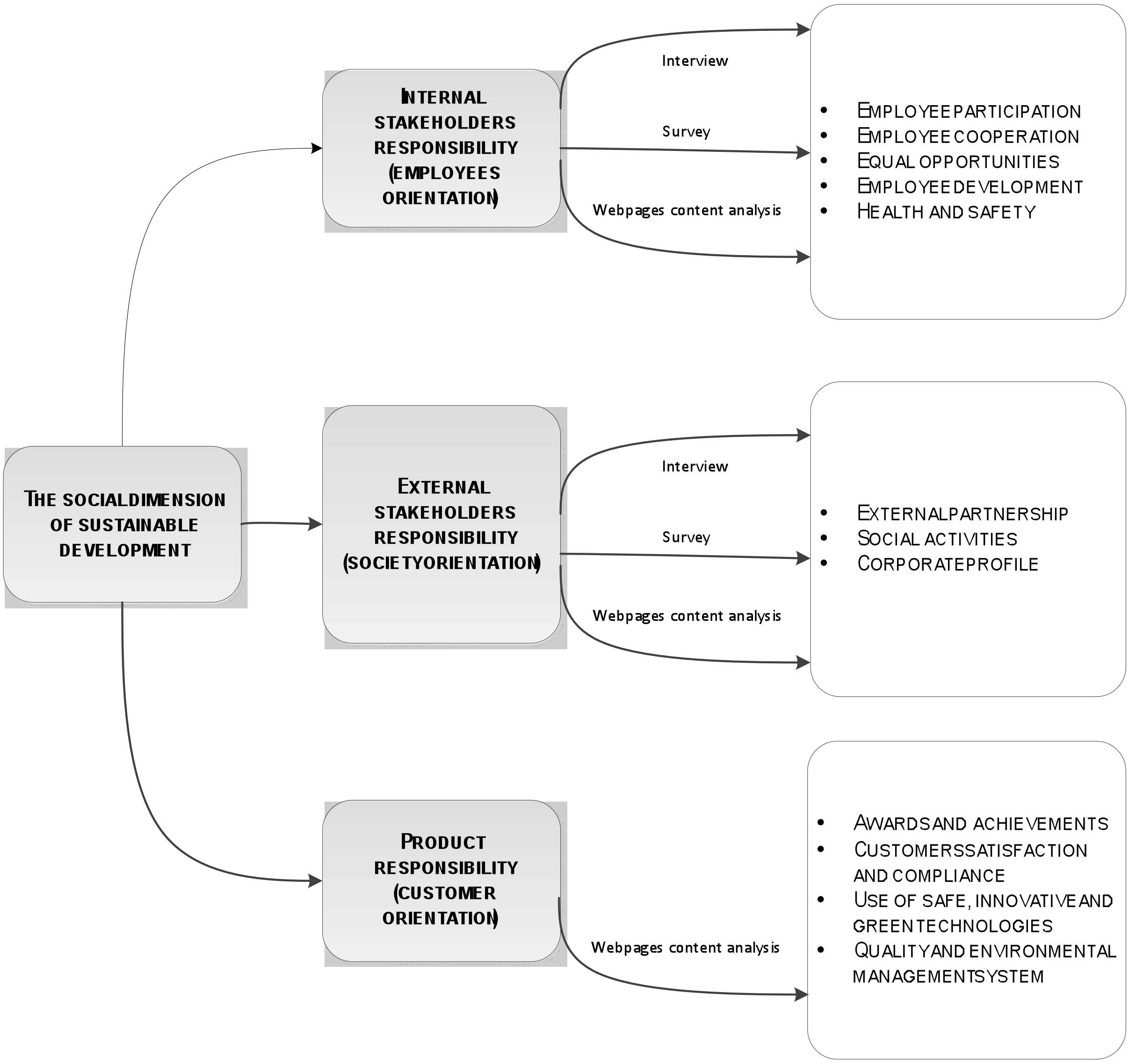

Figure 2. Characteristics and indicators of social dimension of sustainability.

The description of the indicators used in the social sustainability evaluation model (Figure 2):

- *Employee participation* reflects conditions, which organization creates for employees to provide proposals for improvement of organization's activities, to receive information and to participate in decision making.
- *Employee cooperation* allows assessing the nature of relations between employees; it includes not only relations between employees, but also relations between employees and managers.
- *Equal opportunities* mean that labour practices are not based on socio-demographic characteristics of employees. The existence of employees' interests is acknowledged, as well as necessity to reconcile (match) them with organization's interests.
- *Employee development* is related to the development of competences, which employees need now and in the future; it includes screening of the capacities of new employees, the training of employees, the transfer of experience in the organization, the deveplooment of employee's abilities to get employed in the future.
- *Health and safety* is related to safety of workplace within organization.

- *External partnership* includes the organization explanations about the interests, importance, and linking the groups of public with the organization.
- *Social activities* include relations with external stakeholders, trying to ensure the access to workforce, being part of the community and contributing to solution of social problems.
- *Corporate profile* provided for stakeholders explains organization's attitudes, values and corporate strategy, legal form, products and performance results.
- *Awards and achievements* represent the recognition of professionalism on international and national levels.
- *Customers' satisfaction and compliance* explain the possibility to give the feedback (positive and negative) to the organization concerning organizations products through the free customer service line or online provided other organization quality office contact.
- *Use of safe, innovative and green technologies* reveals organization's positive, modern attitude and implemented practices of innovations; the use of renewable energy, the eco-design approach.
- *Quality and environmental management system* represents the implemented ISO or EMAS standards in organization, explains the importance and benefit of these standards for the organization.

Research procedure and data gathering

Interview Design

In the first stage for this research the case study design (Eisenhardt and Graebner 2007) within *interview* method was completed. The interview was carried out in May - June 2015. Data were collected through in-depth, in-person interviews conducted at the wellness centre in Lithuania (hereinafter LitSPA). For pre-study the organization that is the member of the Lithuanian Association of Responsible Business was chosen. The main argument is the assumption that this organization has a deeper knowledge of sustainability and that its activities would confirm and provide the existing examples of the social dimension of the sustainability. The interview sample constituted of 10 management staff representatives. All 10 management staff representatives were professionals working in the LitSPA management team for more than 7 years. Their age ranged from 38 to 52 years old.

Each interview lasted 45 minutes on the average (ranging from 28 to 65 min) and all of them were recorded and transcribed. Qualitative data were analysed by coding and categorising the responses into major conceptual areas.

Various indicators of social dimension of sustainable development were covered during the interview: (1) Employee participation (How can the employee participate in organization's improvement and daily activities?), (2) Employee cooperation (How does the organization encourage employees cooperation?), (3) Equal opportunities (How does the organization consider equal opportunities in labour practices?), (4) Employee potential development (How does organization invest in employees' competence development?), (5) Health and safety (How does the organization invest in health and safety of employees?), (6) External partnership (How does the organization develop relations with external stakeholders - business, non-governmental, educational institutions? What social initiatives are being implemented the organization?).

Questionnaire Design

The questionnaire was developed according to the scientific literature and interview results. The survey was split into seven sections: the first sought to determine employee participation; the second section assessed employee cooperation; the third section aimed to reveal the equal opportunities; the fourth sought to perceive employee development; the fifth section revealed health and safety conditions; the sixth section assessed organization external partnership, while the seventh section analysed subjects' demography.

Data were gathered using a structured self-completion questionnaire from LitSPA employees. The questionnaires were prepared in a paper form. The survey was conducted in November – December 2015.

The total sample consisted of 120 employees of LitSPA. Statistically, the sample size was representative of the population with 5 per cent standard error and 95 per cent confidence level.

The Cronbach's values of the tool were 0.55-0.91 (see Table 2).

SPSS 20.0 for Windows was used to process the collected data. The internal consistency and reliability of the questionnaire developed and piloted for this study was rested with Cronbach's alpha resulting in a level of statistical significance of α = 0.05.

Table 2. The Statistical information about the survey instrument.

Items	Stand. Loadings	Reliability
EMPLOYEE PARTICIPATION		0.74
Employees initiative to participate		0.73
Employees shares with line managers the personal problems	0.86	
Employees shares with line managers the work-related problems	0.85	
Employees provide suggestions concerning the improvements of organization processes	0.59	
Organizations encouragement to participate		0.55
Organization encourages the employees to take responsibility for decisions	0.85	
Organization encourages the employees to provide suggestions concerning the improvements of organization processes	0.72	
EMPLOYEE COOPERATION		0.74
Employee cooperation encouraged by organization		0.65
Organization encourages the employees to cooperate by solving work-related problems	0.90	
Organization encourages the employees to share work-related experience	0.87	
Organization encourages the team working	0.62	
Organization compensates the employees cooperation activities	0.52	
Employees initiatives to cooperate		0.91
Employees provide support for each other by solving work-related problems	0.94	
More experienced employees share the work experience with colleagues	0.93	
EQUAL OPPORTUNITIES		0.71
Equal compensation opportunities		0.83
The compensation system is comprehensive for employees	0.91	
The compensation system is fair	0.89	
The employees for the same work are paid the same	0.65	
Equal work conditions		0.65
Organization ensures equal personal development opportunities for employees	0.77	

Organization ensures equal opportunities for all candidates during selection process	0.77	
Organization ensures equal opportunities for male and female careers	0.60	
EMPLOYEE DEVELOPMENT		0.75
Organization ensures possibilities for employees to develop general and professional competences	0.78	
Employees competences development is oriented to the future requirements	0.74	
Organization ensures possibilities for employees to participate in fairs, internships	0.70	
Organization applies different forms for employees development	0.67	
Organization encourages employees constantly develop their competences	0.66	
HEALTH AND SAFETY		0.70
Safety conditions		0.76
Organization provides for employees needed work equipment	0.87	
The work places fulfil safety requirements	0.86	
Organization encourages employees to give up bad habits	0.72	
Health conditions		0.66
Organization provide for employees good conditions for rest	0.79	
Organization provide for employees wellness opportunities	0.68	
Organization provide for employees good work conditions	0.65	
EXTERNAL PARTNERSHIP		0.79
Organization cooperates with other organizations for employees development	0.87	
At request the organization provides recommendation about former employee	0.78	
Organization accepts students for practice	0.77	
Organization cooperates with other organizations for innovation projects	0.74	

Website Content Analysis Design

A content analysis (Krippendorff, 1980) methodology was used to analyse the social dimension of sustainable development of LitSPA website. The part of the framework of Capriotti and Moreno (2007) which reveals social sustainability is taken as a background. The identified characteristics corresponding to social dimension of sustainable development issues are shown in Figure 2.

The evaluation of social dimension of sustainable development information on organization website was carried out in January 2016.

3. Results and Discussion

The pre-study results revealed that the organization's social dimension of sustainable development is expressed through all three characteristics included in the social sustainability evaluation model (Figure 2) and the mixed method approach enabled to disclose the content of the indicators. The internal stakeholders' responsibility evaluation results are presented in Table 3.

Table 3. Internal stakeholders' responsibility evaluation results.

Interview results			Survey results	Examples provided from the webpage
Theme	Sub-theme	Condensation	Mean (when scale is from 1 to 4) / SD	
EMPLOYEE PARTICIPATION			2,83 / 0,45	Not evaluated
The availability to participate for all	Department's meetings	During the meetings the common suggestions are generated		
	Special position in the organization	Assistant of CEO is responsible for communication with employees		
	Possibility to give suggestions to managers directly (tet-a-tet)	Employees individual express suggestions for managers while the doors are open		
	Participation through IT technologies	Suggestion through intranet		
	Possibility to give suggestions confidently	Anonymous suggestions through internet		
Value created through employee participation	Work environment improvement through participation	Healthy food for employees		
Encouraging employees to participate	Compensation for participation	Non-financial compensation for participation		
EMPLOYEE COOPERATION			2,92 / 0,39	Not evaluated
Supporting employee interaction	Friendly relationships among employees	Employees relations are friendly despite small work-related conflicts		
Perceived employee interdependence	The work-process dependence	If one employee does not fulfil the duties, the workload increases for the another employee in the process		
The employee – employer interaction	The employers pay attention to personal need of employees	The head of department knows the realities and problems of employees		
EQUAL OPPORTUNITIES			2,76 / 0,42	Not
	Equal opportunities	All employees have the		

of labour relations	for development	possibilities to develop their competencies		evaluated
	Equal career opportunities	All employees have the career possibilities inside organization		
EMPLOYEE DEVELOPMENT			2,90 / 0,41	
Value created through employee competence development	The quality of services provided to customers	For top-level service providing it is invested in employee competence development		*„LITSPA celebrates its birthday, and we want to share with You the result of our massage masters' experience: LITSPA classic massage.* *LITSPA masters have been improving the technique of therapeutic classic massage for 12 years"*
	Employee satisfaction	The development of employees increases their satisfaction		Not evaluated
Sharing the experience	Introductory training for employees	New employee receives training on organization's history, philosophy, quality and culture		Not evaluated
	Financial compensation for sharing experience	The employee that shares experience receives the compensation		
HEALTH AND SAFETY			2,96 / 0,42	Not evaluated
Comfortable lounge areas	Lounge area for employees	Employees have possibility to recover in the lounge area		
More healthy employee	Employee wellness programs	Wellness programs for employees as part of compensation		
	The encouragement to give up the bad habits	The employees, who do not have the bad habits, receive extra wellness programs		
	The health prevention	The compensation (full or partly) of health diagnostics		

	programs for employees	for employees		
	The health knowledge providing	Internal lectures on health issues for employees		

Concerning the employee participation (Table 3) the managers of organization perceive the value created through employee participation, ensure the possibility for all employees to participate and apply some compensation mechanism. The diversity of participation forms, as intranet, internet, "open door" policy, meetings and special position, allows for the organization to collect ideas and improvement suggestions from employees. The desire of employees to contribute to value creation by participating is encouraged by the organization providing non-financial compensation. The survey results reveal the same tendency and indicate congruence between managers and employees evaluation of employee participation (mean – 2,83). The research findings support Boström's (2012) interviews results that participation is one of the multitude aspects of social sustainability that requires the active efforts of organizations and encouragement of employees. As regards the employee cooperation the interview results disclosure the supporting nature of relationship between employees despite the small work-related conflicts. The managers highlight the interdependence of employees in work process. The employee-employer interaction allows to strength the cooperation in daily work activities. The employee cooperation in daily practices is confirmed by survey results (mean – 2,92) and reveals the congruence between the managers and employees attitudes. The transparency of labour relations from managers' point of view is expressed by employees' equal opportunities for development and career inside the organization. The employees recognize the equal opportunities, but not in the same scale as managers (mean - 2,76). This indicates for the organization the necessity to communicate the equal opportunities policy. Gender issues, according to Boström's (2012) research findings, are one of the aspects that reflects the expression of social sustainability. The interview results indicate two pathways of organization's activities in the employee development field. The first pathway is the investment in employee competencies development creating value for both the organization and employees themselves. The second practice reflects the encouraging of experience sharing among employees. The employees survey results confirm the same tendency (mean – 2,90). The interview results expose that the organization ensures health and safety conditions for employees. The attention is paid not only for comfortable lounge areas. The main focus is on the healthier employee: the health prevention programs; the wellness programs and health knowledge are provided. The employee survey confirms that the health and safety practices are implemented in the organization (mean - 2,96). According to survey results, the employees mostly agree that the practices of the health and safety and the employee cooperation are implemented in the organization. The practices identified during the research are in line with the research of Labuschagne et al. (2005) who stated that "health and safety" should manifest on a higher level within social sustainability evaluation framework. The conclusion could be made that the managers of pre-study organization underline the same trends concerning the organization internal stakeholders' responsibility.

The external stakeholders' responsibility evaluation results are presented in Table 4.

Table 4. External stakeholders responsibility evaluation results.

Interview results			Survey results	Examples provided from the webpage
Theme	Sub-theme	Condensation	Mean (when	

			scale is from 1 to 4) / SD	
EXTERNAL PARTNERSHIP			2,92 / 0,47	
The unity of business, research and studies	The formation of the pool of potential employees	The student practical training (internship)		The internship possibilities are provided in website
		The organization seeks to retain the students after the internship		Not evaluated
	Purposeful continual cooperation	The partner in students championships		Not evaluated
	The solving of business problems	The organization suggests real business problems for final students thesis		Not evaluated
The interaction between the organization and local business companies	The society-oriented business model	Business development together with local business community business companies		*"Ecological and/ or local production, fresh meat, fish, seasonal fruit, berries and vegetables, our baked bread, extra virgin olive oil from Spain, Lithuanian linseed oil and unique herbal teas."*
SOCIAL ACTIVITIES			Not evaluated	Not evaluated
The partnership with local community	The support for social and cultural initiatives	The support for music and theater festivals		
CORPORATE PROFILE			Not evaluated	
The corporate profile communication	The information for local community about the business development	Continual communication through local press and meeting with local communities		"SPA etiquette consists of some rules or standards of behaviour which one should

				know before going to any SPA centre" Specialists achieveme nt are provided" / The career possibilities are provided

According to interview results, the external partnership of organization (Table 4) is exposed by the interaction between the organization and other local business companies and educational organizations. The cooperation with educational organizations helps for organization to create a pool of potential employees and to receive the suggestions for business issues solutions through scientific researches done by students. The interaction with local business companies reveals the society oriented business model. This practice of organization confirms the corporate sustainability of organization. The employee survey results show the congruence between managers and employees evaluation of external partnership (mean – 2,92). Concerning social activities, the managers provide the examples of supporting social cultural initiatives. The webpage content analysis does not provide any information about the support of local community events. The interview results reveal that corporate profile is communicated continual to local community. This is confirmed by webpage content analysis: full description of provided services, SPA etiquette, employees' profiles and achievements and etc.

The product responsibility evaluation results are presented in Table 5.

Table 5. Product responsibility evaluation results.

Indicators	Examples provided from the webpage
AWARDS AND ACHIEVEMENTS	*"LITSPA won a Perfect SPA Brand award in an annual SPA and Wellness International Congress"*
CUSTOMERS SATISFACTION AND COMPLIANCE	*„HOTLINE INFORMATION* (How to get there? The restaurant/bowling opening hours? Table reservation at the restaurant? What concert? SPA centre/ swimming pool/gym opening hours?)" *„QUALITY DEPARTAMENT* (Reviews. Offers. Opinions. Complaints)"
USE OF SAFE, INNOVATIVE AND GREEN TECHNOLOGIES	*"Old health resort research traditions are retained up to now: treatments using mineral water, therapeutic mud, kinesiotherapy and vertical baths. A nearby mineral water spring is the greatest LITSPA treasure, supplying highly mineralized water directly to the health centre. Mineral water, rich in curative properties, and curative mud are as good as in the most famous European sources"*
QUALITY AND ENVIRONMENTAL MANAGEMENT SYSTEM	*"2nd of January 2015 LITSPA received certificate for the management system according to ISO 9001:2008"*

The degree of websites' or other internet channels interactivity (Capriotti & Moreno, 2007) shows the speed of information dissemination and encouraging dialogues between organization and different stakeholders.

Based on the webpage content analysis the product responsibility indicators are disclosed. The organization provides the comprehensive information about its awards and achievements in the separate section of the webpage. Also the personal awards of employees are described. Striving to ensure the customers' satisfaction and appropriate analysis of compliances the organization provides hotline information and quality department phone for reviews, offers, opinions and complaints. The organization's use of safe, innovative and green technologies is not clear described on the webpage. This shows that the webpage is more oriented to customers than to other business partners. For the customers the organization emphasizes the natural resources and old health resort research traditions. The organization received the quality certificate only one year ago and it shows the commitment to quality assurance. The webpage content analysis of product responsibility supports the expression of the social dimension of sustainable development.

The paper contributes to the evaluation of social sustainability by providing the complex model, which encompasses the original set of the characteristics and the indicators and includes the wide range of stakeholders. Stakeholder theory provides some insights to the organizations how to effectively deal with three problems, which are relevant from the lens of social sustainability: the problem of value creation and trade, the problem of the ethics of capitalism and the problem of managerial mindset (Parmar et al., 2010). Referring to the attitude that social sustainability is based on multi-faced social values (Almahmound and Doloi, 2015), the model proposed in our paper strongly focuses on the achievement of the coherence in internal and external stakeholders' understanding, as well customer understanding. As social sustainability refers to individual and collective levels (Lehtonen, 2004), the model emphasizes the need to evaluate social sustainability not only from the viewpoint of the management staff, but also on the level of employees. The model also includes the evaluation of organization's social sustainability communicated to society through website.

Striving to present the comprehensive view on social sustainability of the different stakeholders, the model proposes mixed method approach. Hereby, the understanding of different stakeholders as regards internal stakeholders' responsibility, external stakeholders' responsibility and product responsibility is evaluated using different methods and enables to solve one of the challenges related to evaluation process – the data complexity.

5. Conclusions

The literature review on sustainability evaluation frameworks reveals various social dimension structures and different evaluation approaches. The majority of evaluation frameworks suggest the quantitative approach. The framework proposed in this paper contains three characteristics of the social dimension of sustainability: internal stakeholders' responsibility, external stakeholders' responsibility and product responsibility. This framework opens the space for more discussions and agreements among organizations stakeholders.

The used mixed method approach enables to evaluate the social dimension of sustainable development in organization from three different perspectives: top management approach, employees' perception and public available information to other stakeholders. This allows for organization to disclose the coherence of expression of social dimension among internal and external stakeholders.

The statistical and communicative validation of research instruments in the pre-study allows using these instruments for further research. The combination of the qualitative and quantitative methods allowed getting better understanding on social dimension of sustainable development.

The proposed model is more scientific than practice oriented and could be developed in such pathways: first, the employees and managerial staff could be asked to evaluate the product responsibility; second, not only website but also other publically available organization documents could be analysed.

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Assessing national potentials of sustainable development from a child's perspective - a proposal of Sustainable Child Development Index (SCDI)

Ya-Ju Chang and Matthias Finkbeiner

Abstract

Children are a key stakeholder group for sustainable development (SD) as they represent the interface between current and future generations. Despite the relevance of children in inheriting and shaping the society in the context of sustainable development, children are neglected in many sustainability assessment studies. As the needs of children and their susceptibility to external factors are different from those of adults, schemes and indexes for evaluating SD from a child perspective, that is sustainable child development, need to be developed independent of whole-population-oriented assessments. Currently, a widely-accepted, clearly-stated and comprehensive index system to evaluate child development (CD) in the context of SD is still missing. Besides, environmental and resource consumption aspects are often neglected in the existing CD studies. Thus, the aim of the study is to develop a composite Sustainable Child Development Index (SCDI) at country level, covering relevant topics of CD by considering hierarchical classification and environmental aspects. In this study, as a first phase, the main topics of CD are categorized into 7 themes through the literature review: health, education, safety, economic status, relationships, participation, and newly proposed environment aspects. The corresponding 48 subthemes and 98 criteria are classified accordingly (e.g., the subtheme risk behavior, child mortality, oral health, etc., are assigned to the theme health). Furthermore, to measure the identified topics, indicators are then collected and selected as an applicable indicator set considering their data availability. As a result, 65 indicators with statistic data covering at least 100 countries are suggested as an applicable indicator set of SCDI. The themes health and education account large share of the identified indicators and own superior data availability. On the other hand, the themes relationship and participation obtain many indicators in very low data availability level, hardly to apply in SCDI in practice. Hence, further development of indicators for the themes and data is the key to overcome this challenge. Proposing suitable calculation and aggregation methods are the main future work for constructing a composite SCDI. The proposed index intends to strengthen the stakeholder perspective of children in sustainability assessment, providing a novel way to measure the potential of sustainable development of countries.

Keywords: sustainability assessment; sustainable development; child development; Sustainable Child Development Index (SCDI); composite index; indicator set

Emergy as a measure to assess sustainable development

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Abstract

Emergy accounting is one of the methods in the sustainability assessment toolbox. In its use of stocks and flows of energy and matter it has similarities with Material Flow Analysis (MFA), Substance Flow Analysis (SFA), and Life Cycle Assessment (LCA), but Emergy accounting also includes stocks and flows of money and information. In its methodological approach of relating to a global baseline of renewable flows Emergy accounting is similar to Ecological footprints in that it is not just revealing which of two alternatives is using more or less of different stocks or flows but also comparing the use to available renewable flows on a global annual basis.

This paper address the contribution of three different aspects of emergy accounting (emergy analysis, emergy synthesis) to the overarching goal of sustainable development. The discussed aspects were: 1) the Emergy Sustainability Index (ESI), 2) emergy as a normalizing measure, and 3) emergy as a network measure.

It was concluded that the Emergy Sustainability Index (ESI) is an interesting measure but does not catch the full range of the sustainability concept. The emergy accounting approach, with the ESI as part of it, has a lot more to say about sustainability than just what is captured by the ESI. An interesting outcome is that the traditional triple-bottom-line of environmental, economic and social sustainability emerges very easily from the emergy assessment conceptual diagram approach. Emergy accounting holds a promise of clarifying the fuzziness often connected to how to classify economic, social, and socio-economic domains of sustainability. These are in practice often difficult to distinguish between, as are their connections to the ecological/environmental sustainability. The reason why the ESI captures only a small part of what is interesting from a sustainability point of view in the full emergy assessment may be that it has the focus on the traditional load and yield components. Many of the interesting parts from emergy evaluation in the sustainability context may instead come from the capability of emergy accounting to capture network properties.

Keywords: ESI, system network, system sustainability

1. Introduction

Emergy accounting is one of the methods in the sustainability assessment toolbox. In its use of stocks and flows of energy and matter it is similar to Life Cycle Assessment (LCA), Material Flow Analysis (MFA) and Substance Flow Analysis (SFA). However, Emergy accounting also includes stocks and flows of money and information. In its mechanism of relating to a global baseline of renewable flows Emergy accounting is similar to Ecological footprints in that it is not just revealing which of two alternatives is using more or less of different stocks or flows but also comparing the use to available renewable flows on a global annual basis. The latest global emergy baseline was calculated to 12.1 x 10^{24} seJ/year (Brown and Ulgiati, 2016).

This paper address the contribution of three different aspects of emergy accounting (emergy analysis, emergy synthesis) to the overarching goal of sustainable development. Section 3 has its focus on the Emergy Sustainability Index (ESI), section 4 on emergy as a normalizing measure, and section 5 emergy as a network measure.

2. Emergy and the Energy Hierarchy Principle

Emergy is a measure appearing when applying the energy hierarchy principle to natural (e.g. forests and lakes) or human (e.g. cities and countries) systems. The principle postulates that energies in any system will self-organize in hierarchical patterns given time to do so (Odum, 1994, 2007). Emergy is expressed in relation to one type of energy occurring in the hierarchy, almost always solar emergy Joules, seJ. In the context of economy, emergy values can alternatively be expressed in a currency related unit, for example Em€ or Em$ (proportional to values in seJ). The significance is that Em€ or Em$ measures the contribution different items gives to the whole system, rather than how individuals value different items on the market; a donor value approach rather than a receiver (market) value approach. Emergy accounting use many different indices (Brown and Ulgiati 2004) based on stocks and flows of renewables (R), non-renewables (N), feedback from other systems higher up in the energy hierarchy (F), and the yield or contribution from the system evaluated (Y), see Figure 1. Examples of indices are percent renewable (%R) and Emergy Investment Ratio (EIR=F/(R+N)).

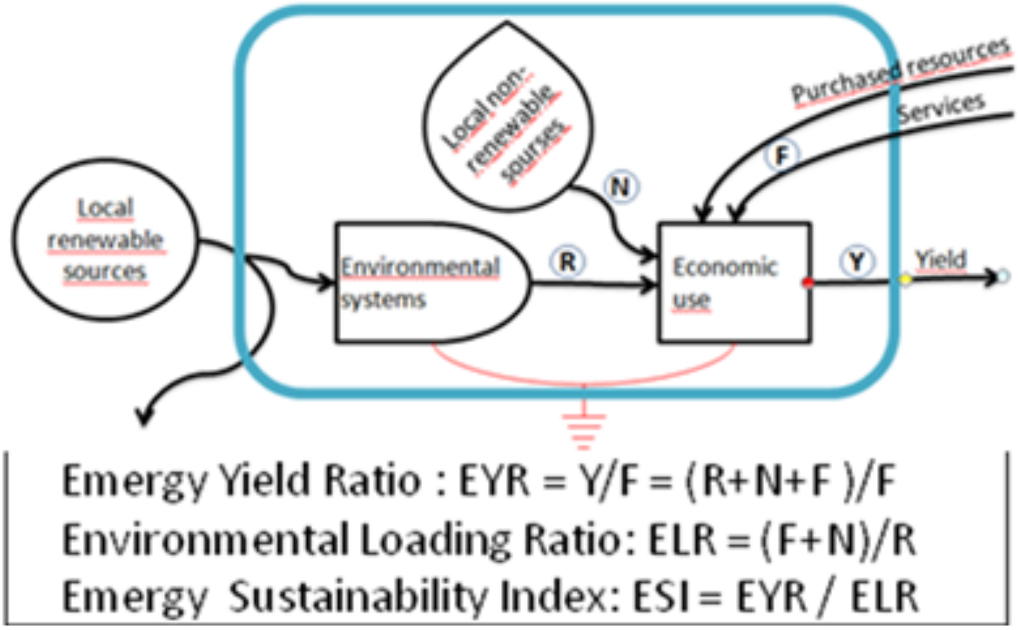

Figure 1. The Emergy Sustainability Index, ESI (after Brown and Ulgiati 2004).

3. ESI, Emergy Sustainability Index

The ESI was introduced by Brown and Ulgiati (1997) and Ulgiati and Brown (1998) as "…an aggregate measure of economic (large yield) and environmental (low stress) compatibility." It is defined as the Emergy Yield Ratio divided by the Environmental Load Ratio (Figure 1). It captures, on the yield side, the contribution of an activity (e.g. forestry or fish farms) to the larger system (e.g. society), and on the stress side the increasing load on the local system (which original state is measured by R) from released local non-renewable recourses (N) and purchased recourses introduced to the local system (F). The ESI measure has since been frequently used by many authors, often interpreted in a far more general way than originally suggested by Brown and Ulgiati (1997). An interesting discussion regarding the ESI was published as Letters to the editor in the journal *Ecological Modelling* during 2011 and 2012 (Harizaj, 2011; Brown and Ulgiati, 2011; Giannetti (2012). The focus of the discussion was what factors would maximize the ESI. Of course high yield (EYR) and low load (ELR) will do it, but in which constellations of R, N and F. The outcome of the discussion was that it was clear that the ESI still needs refining and that it "…does not capture the complexity of the sustainability concept" (Brown and Ulgiati, 2011).

4. Emergy as a normalizing measure

The probably most attracting feature of emergy accounting is its mechanism of normalizing flows not only between energy and matter, but also between energy and money (Odum 1996); this is almost unique among environmental assessment methods. Thus when drawing an emergy diagram (according to Odum 1996 and Brown and Ulgiati 2004), it is not only possible to illustrate flows of energy, matter, information, and money within the same diagram, it is also possible to put values on all of the flows with the same unit: seJ (solar emergy Joules). From a sustainability point of view it is also interesting that when using the energy hierarchy diagrams of emergy accounting, the domains of the traditional triple-bottom-line approach in the sustainability debate comes out naturally (Grönlund et al. 2008), see Figure 2. In each of the three domains it is possible to use the normalized quantitative numbers of emergy regardless of the original units of the flows, be it Joules, kg, bits or Euros (at least in theory, the social sustainability parts are still problematic in the collection of raw data).

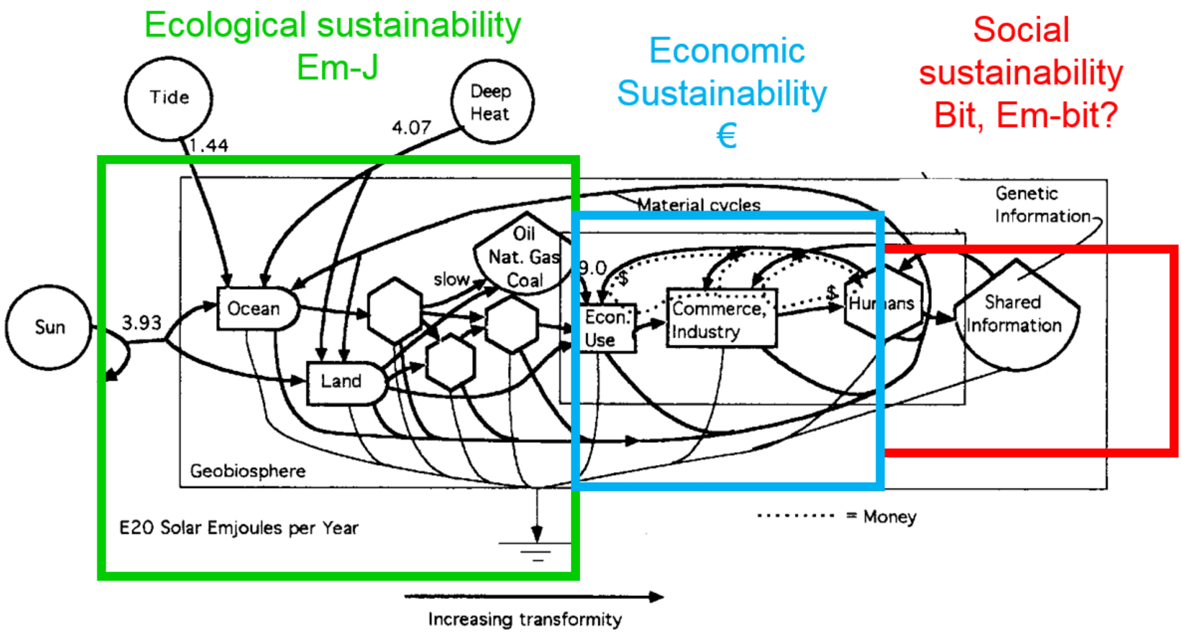

Figure 2. The triple-bottom-line domains in the energy hierarchy (modified from Odum 1996, Figure 3.1, by Grönlund 2008).

5 Emergy as a network measure

An aspect of the emergy accounting approach that has not been explicitly discussed in the sustainability literature so far is the feature of emergy as a network measure rather than a "state variable" measure. The energy hierarchy has been suggested as a new thermodynamic (TD) law since it claims to describe distribution and dynamics of energy in universal terms (Odum 1994). Grönlund (2009) and Grönlund and Brandén Klang (2009) suggested that a problem for this suggestion to have a breakthrough as an accepted TD law is due to the fact that it expands the classical TD (heat TD, Figure 3). This expansion is not performed by those who work with the classical TD (i.e. heat engine and chemical engineers) but by other research groups who are not used to view their work as TD (Figure 4). These groups are for example business modellers, computer scientists, and meteorology modellers working with theories of networks, systems, and complexity (Figure 4). The expansion also includes the new systems ecology measures with a network focus as Environs (Patten 1992), Ascendancy (Ulanowicz 1997) and Emergy (Odum 1994) (Figure 4). A special case is the measure Eco-exergy (Jørgensen 2006) which takes its fundaments much more explicit in the old classical TD but address the new quality aspects. Grönlund and Brandén Klang (2009) suggested that also the Extended Exergy concept (Sciubba 2003) is taking this step by adding money to the classical TD.

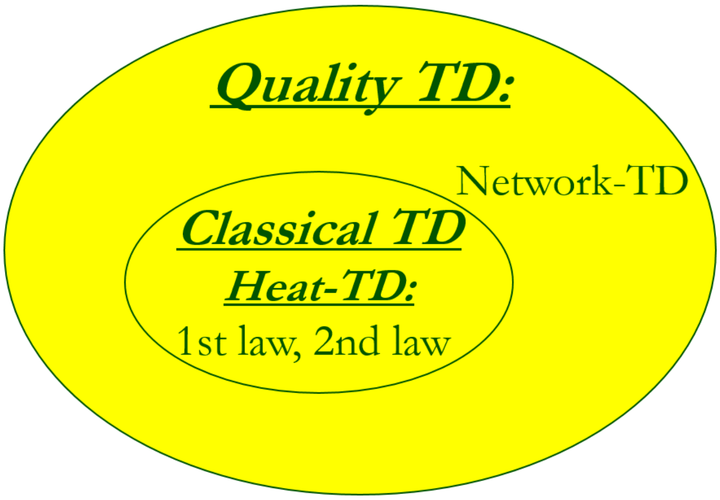

Figure 3. A view of the expansion of the field of thermodynamic (TD) from the classical heat TD to quality TD including network TD (from Grönlund and Brandén Klang 2009)

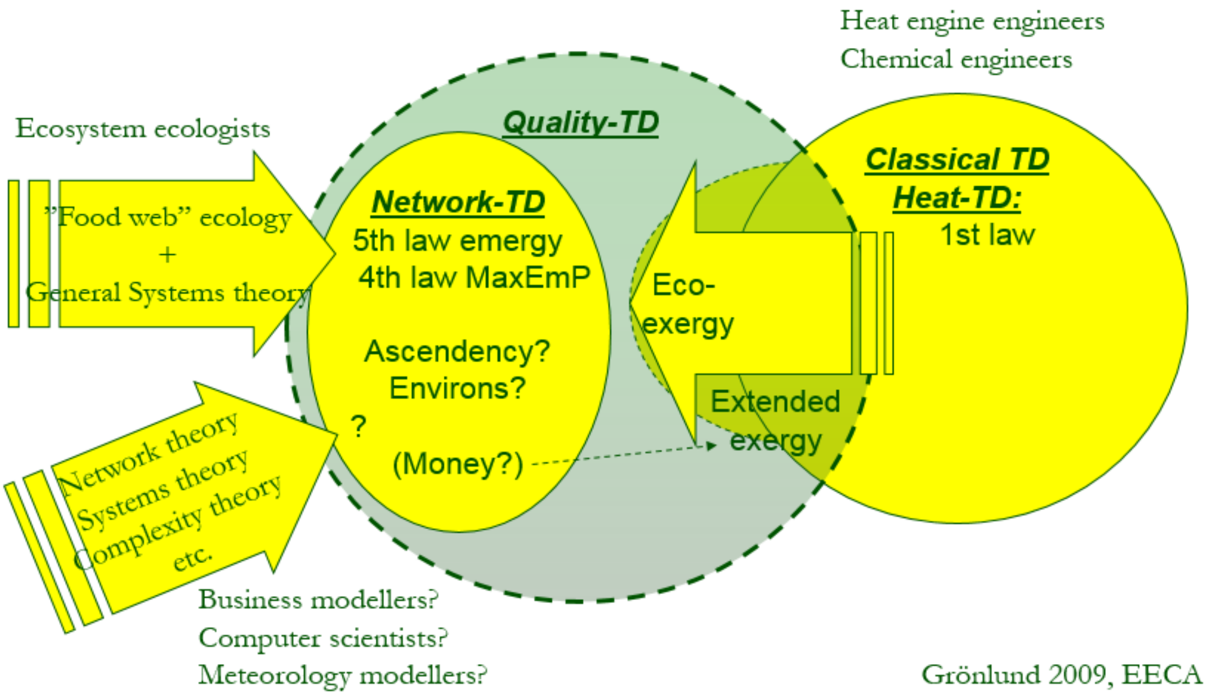

Figure 4. A suggested thermodynamic classification of the new ecosystem theories emerging (from Grönlund and Brandén Klang 2009).

6. Conclusions

It was concluded that the Emergy Sustainability Index (ESI) is an interesting measure but does not catch the full complexity of the sustainability concept. The emergy accounting approach, with the ESI as part of it, has a lot more to say about sustainability than just what is captured by the ESI.

An interesting outcome is that the traditional triple-bottom-line of environmental, economic and social sustainability emerges very easily from the emergy assessment conceptual diagram approach. Emergy accounting holds a promise of clarifying the fuzziness often connected to how to classify economic, social, and socio-economic domains of sustainability. These are in practice often difficult to distinguish between, as are their connections to the ecological/environmental sustainability.

The reason why the ESI captures only a small part of what is interesting from a sustainability point of view in the full emergy assessment may be that it has the focus on the traditional load and yield components. Many of the interesting parts from emergy evaluation in the sustainability context may instead come from the capability of emergy accounting to capture network properties.

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Downscaling Planetary Boundaries to Semi-Arid Ecosystem: An Assessment with Local Perception in Middle Reaches of Heihe River

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Abstract

The middle reaches of Heihe River are located in the oasis of the Gobi Desert where limited freshwater supply supports more than 1.5 million inhabitants. The intense agricultural activities, primarily seed corn productions, are depleting the groundwater reserve. Consequently, natural landscapes and habitats are degraded. Though such development improves the livelihood of the local community, long-term sustainability of the ecosystem is at risk. Local authorities must be informed holistically to prepare for adapting to the changes and/or mitigating the impacts. Based on the safe operating space framework (or Planetary Boundary, which quantifies the state of sustainability with ecosystem capacity of tolerating human impacts), nine boundaries ranging from climate change to biodiversity loss are critical to be safeguarded. However, for implication at regional level, the indicators and boundaries must be downscaled. This research aimed to develop a sustainability assessment framework for the semi-arid ecosystem using a combined top-down and bottom-up approaches. First, we analyzed the environmental boundaries using data from monitoring stations and on-site samplings; each boundary was categorized into three stages, i.e. safe, uncertain, and high risk. To supplement the insufficient of regional data and explore the sustainability implication to local community, we then conducted interview survey to twenty-one local villages. We assessed local perception on environmental disasters and potential impact on local livelihood. Our findings showed that five ecological dimensions had significant thresholds at the ecosystem level, i.e. freshwater use, biogeochemical flow, atmospheric aerosol loading, land-use change, and novel entities. The indicators and boundary definitions were locally contextualized to overcome the data limitations. For example, the current freshwater use of 2.39 m^3/year was reported as high-risk which was defined based on the stable groundwater recharge of the region over last three decades. The boundaries for biogeochemical flow which was measured in nitrate and phosphate concentrations in the river, and atmospheric aerosol loading which was measured in PM10, were set based on the National Environmental Protection Law. The impact of land-use change was associated with freshwater use but the quantification was impossible because of the complex interaction between factors. Alternatively, the boundary was set as 20% of natural landscape coverage according to the government's target. Pesticide accumulation was defined as the indicator for novel entities. The results from interview confirmed the overall findings in previous scientific assessment. We highlighted the applicability of alternative knowledge, i.e. environmental risk perception of local inhabitants, to supplement the scientific knowledge, particularly when regional data was lacking. In addition, we were able to show the implication of transgressing ecological boundaries, i.e. impacts on local livelihood, with complemented social survey. In conclusion, this paper proposed a unique framework to perform regional sustainability assessment. Demonstrated in the case study, the proposed framework is practical for decision makers and expandable to other developing countries, where scientific monitoring data can be expensive.

Keywords: Sustainability Assessment, Semi-arid Ecosystem, Local Perception, Planetary Boundaries, Regional Safe Operating Space

1. Introduction

The Heihe River Basin is an inland river basin (or oasis) in the Gobi Desert, northwestern China. The enclosed semi-arid ecosystem has minimum rainfall (Shi et al., 2014). Freshwater is supplied predominantly by Heihe River, which originates from the snowmelt and glacier melt of Qilian Mountains. Despite limited water resources, the basin is supporting more than 1.5 million inhabitants. Intensive human activities have been exerting pressure on the natural environment over the past 2000 years (Cheng et al., 2014). Historically, the basin was a strategic location for defense against nomadic tribes and function as a trading post of ancient Silk Road. Irrigation system that diverts water from the river has been widely introduced to produce enough food for growth (Yaowen et al., 2013). Consequently, artificial oases with crop plantations have replaced natural oases (Geng et al., 2015; Cheng et al., 2014). In the twentieth century, agricultural activities have shifted to cash crop plantations, especially for water-effective seed corn (Shi et al., 2014). However, the expansion of farmlands causes more water stress and induces water conflict (Wang et al., 2015). In fact, desert area has shrunk by 7% from 2011 to 2010 due to conversion to arable lands (Jiang et al., 2015). Excessive fertilizer application also increases nutrient loading to the water system while pesticide and herbicide residue pollute the soil. The local government is therefore implementing industrial transformation to reduce dependence on agriculture by promoting secondary industry (e.g. mining, food processing, and manufacturing) and tertiary industry (e.g. service industry and tourism) (Wu et al., 2014). In dealing with these multi-dimensional pressures, local policymakers must be supported with a holistic view of the sustainability status of the local ecosystem for future planning. In this manner, economic development which simultaneously delivers livelihood improvement without risking ecosystem integrity can be realized.

Planetary Boundaries (PB) is a comprehensive assessment method for determining the sustainability status of planet earth (Rockstrom et al., 2009; Steffen et al., 2015). PB categorizes anthropogenic impacts into critical ecological processes, i.e. climate change, nutrient flow, freshwater use, ocean acidification, air pollution, ozone depletion, land-use change, biodiversity loss, and man-made chemical pollution. With quantifiable indicators and boundaries definitions, PB describe the safe operating space for humanity (or health of ecosystem) concisely in three states, safe, uncertain, and high risk. Hence, PB has been useful in facilitating discussion of the sustainable development agenda in United Nations (Dearing et al., 2014; Hajer et al. 2015). Although PB is intended for global scale assessment, many studies have shown the merits of downscaling PB to regional level (Cole et al., 2014; Dearing et al., 2014; Nykvist et al., 2013). One reason is, practically, national governments and provincial governments have higher autonomy in launching conservation actions. If guided by downscaled PB framework, environmental conservation can be tailor-made for reflecting local priorities without losing the consideration of global sustainability. Downscaling PB involves dimension selection, indicators selection, and boundaries definition. Dearing et al. (2014) proposed to define the safe/high-risk boundaries by first characterizing ecological processes into four pattern types based on their nature—linear trends, nonlinear trends, thresholds, and early warning signals—then decide the state based on observation of historic data. Nykvist et al. (2013) proposed to allocate the allowable emission/effluent using per capita and other factors, as boundaries definition for processes without a specific regional threshold such as climate change. Cole et al. (2014) used mixed methods based on expert judgment to select the most suitable sets of indicators for assessment of South Africa. Although these studies demonstrated the feasibility of downscaling PB from top-down perspectives, they notably demanded large amount of local datasets that were not always available. As such, in the most common situation, there is likely to be a situational compromise between an unavailable ideal indicator (i.e. good resolution and accurate) and an alternative proxy (i.e. low resolution but reasonable).

This study proposes to complement the top-down approach of downscaling PB with a bottom-up assessment—using local's perceived risk of environmental disasters—to define regional safe operating space (RSOS). Environmental psychology studies have showed that the formation of local perception is often associated with living experiences, observed changes in environment, and other factors varying with specific socio-cultural background (Brechin and Bhandari, 2011; Sell and Zube, 1986; Soini et al., 2011; Green, 2005). Environmental boundaries in PB or RSOS can be viewed as gradients of increasing risks of environmental disasters (Raworth, 2012). Treating the state of RSOS as potential threats to local livelihood, allows for the consideration of vulnerability in the communities. Vulnerability, in this sense, can be understood as a pre-event state function of the exposure and sensitivity of the system, or as local manifestation of social response to biophysical risk (Cutter et al., 2008). Perception of rural farmers who have livelihoods dependent on the natural environment inherently possess tacit knowledge for estimating the sustainability of local environment. With appropriate field survey design, local perceptions can be harnessed systematically, and thus represent the variation of ecological processes at small community level. This knowledge provides additional realistic on-site detail that is often lacking in top-down approaches.

Developing actions to overcome environmental disasters require the integration of information given by biophysical researches and understanding of how risks are perceived by local inhabitants (Cvetkovich and Earle, 1992). Because individuals are sensitive to environmental risks that potentially impact their livelihood (Lee et al., 2015; Grothmann and Patt, 2005). Surveying local perception can therefore help policymakers predict public responses to a given conservation effort (Brod et al., 2004). Lee and Zhang (2005, 2008) showed that perceptions of local communities on environment are interconnected with their behavioral responses of resisting, adapting, accepting, or actively promoting change, in an arid ecosystem, Northern China. As noted by Raworth (2012), an intervention in a regional environment could have an effect on the associated social foundation. Intervention aimed at improving livelihood could in turn impacts the environmental boundaries. As such, the dynamics of the environmental boundaries and social foundations are tight, therefore the policies for sustainable development need to be appropriately informed and adapted to the practicalities and motivations of regional governance systems to maximize policy influence (Dearing et al., 2014).

In this study, we aimed to develop a novel methodology in downscaling PB. We proposed a RSOS framework based on combining the top-down and bottom-up approaches. The study area was the middle reaches of Heihe River, which is from Yingluoxia to Zhengyixia hydrological stations (Figure 1). The region covers three districts, Zhangye, Linze, and Gaotai that consist of 91% of the population, 95% of cultivated land, and generates more than 80% of GDP, in the Heihe River Basin (Wu et al., 2014). Therefore, the development in this region plays a critical role in ensuring regional sustainability. Our specific objectives were 1) to assess the current environmental status of study area based on downscaling PB with best available scientifically-based data, 2) to assess local perception on the current environmental status through a field survey, and 3) to survey local perception on how environmental disasters might impact their livelihood. We highlighted that perception-based bottom-up approach can meaningfully complement a conventional top-down assessment of safe operating space.

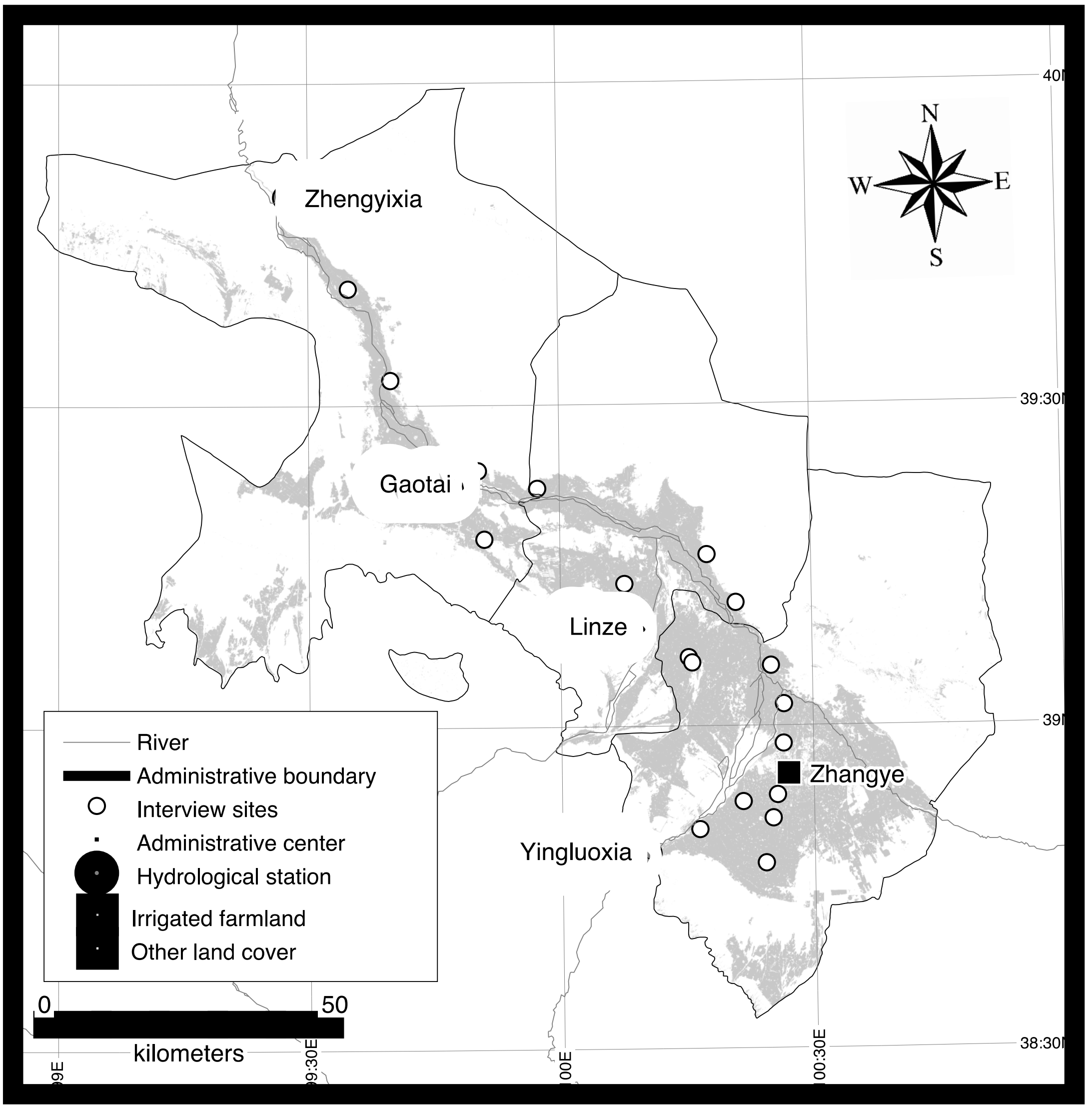

Figure 1. Map of the study area—the middle reaches of Heihe River Basin, which begins from Yingluoxia and ends at Zhengyixia (grey circles), and covers three districts: Zhangye, Linze, and Gaotai. White circles represent the selected interview sites.

2. Methods

This study is designed with two main components: downscaling the PB framework into local ecosystem or RSOS (in section 2.1), and complementing RSOS assessment with local perception and knowledge (in section 2.2).

2.1 Downscaling Planetary Boundaries to Regional Safe Operating Space

PB defines the sustainability of planet earth in nine dimensions, however, not all of the dimensions have a threshold at regional ecosystem level (e.g. climate change). Studies like Nykvist et al. (2013) and Cole et al. (2014) downscaled these dimensions by allocating a fair share (of emission or pollution) to each of the countries according to their population and other economic factors. We instead excluded these dimensions as they were beyond the scope of this study, i.e. climate change, ocean acidification, stratospheric ozone depletion, and biosphere integrity. We then examined whether the indicators in the remaining five dimensions could represent the regional environment and if relevant data was available, i.e. freshwater use, biogeochemical flow, land-system change, atmospheric aerosol loading, and novel entities. If not, we selected the best alternative with expert judgement. We estimated the current status based on on-site sampling and data collected from monitoring stations. Next, we examined whether the definition of boundary condition in PB was applicable at regional level. If not, we redefined the boundary with existing environmental regulations or with the government's goals. Finally, we classified the current status in three levels, i.e. high risk, uncertain, and safe, in response to the local ecosystem thresholds. The overview of decision-making process of dimension selection, indicator selection, and boundary definition to develop our regional sustainability assessment was shown in the flow chart (Figure 2).

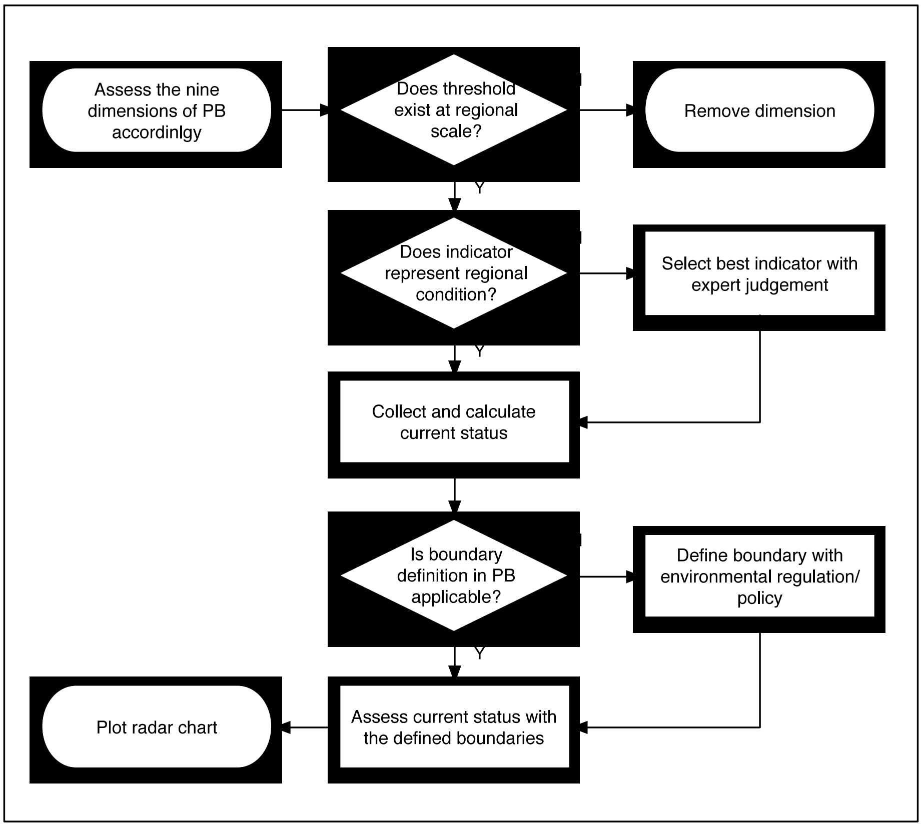

Figure 2. Decision-making flow chart of downscaling the environmental dimensions, indicators, and boundary definition from Planetary Boundaries to Regional Safe Operating Space.

2.1.1 Freshwater use

Freshwater is a critical resource in the oasis, hence it is fully controlled by local authority. A dam, Yingluoxia, is constructed at the entry point of the middle stream of Heihe River. It allocates the water between Heihe River and the irrigation channels depending on farming seasons and ecology conservation requirements. The original PB indicator, blue water withdrawal rate relative to mean river flow, does not consider the human intervention of water allocation, and is therefore inappropriate to describe the regional water boundary. Alternatively, we defined the high-risk boundary as the level of water consumption exceeding the freshwater availability, and the safe boundary as 20% less consumption than the freshwater availability. We estimated the total available water was 2.25 to 2.5 billion m^3 annually according to Gansu Water Resource Bulletin (Wang et al., 2015; Li et al., 2015), of which 85% was river water and 15% was groundwater (Wu et al., 2014). The water consumption of Zhangye was 2.39 billion m^3 in 2010 and agriculture accounted for 94% of the consumption (Li et al., 2015). Although the indicators might not be precise, we had observed adverse impact of overusing freshwater—decreasing groundwater level from 1985 to 2000 at multiple sampling points (see S1 in Appendix A).

2.1.2 Biogeochemical flow

Nitrogen and phosphorus govern the primary production in water ecosystem, particularly in lake and marine ecosystems. Heihe River is an inland river that easily dries up in downstream areas, otherwise it ends at terminal lake in the desert. Since agricultural activities were intense in the middle reaches, we estimated the impact of biogeochemical flow by measuring the nitrate and phosphate concentration in the water of Zhengyixia hydrological station, the exit-point of middle stream of the river. The nitrate concentration was 1.49 mg/L and phosphate concentration was 0.2 mg/L based on test kit analysis. We defined the boundaries based on environmental quality standards for surface water in China (China, 2002). The high-risk boundary was 2 mg/L of total-N and 0.4 mg/L of total-P, and the safe boundary was assumed to be half of the limits. Although severe eutrophication damage was rarely noticed in a water-scare ecosystem, we observed that nitrate and nitrite had infiltrated to some groundwater systems (see S2 in Appendix A). For local residents that depended on well water, health damage was possible if the nitrite concentration exceeded the drinking water standard.

2.1.3 Land-system change

Land-system regulates climate—exchange of energy, water, and momentum between the land surface and the atmosphere (Steffen et al., 2015). Forested land should be preserved in a reasonable percentage in each biome. We defined the indicator as the total coverage area of grassland, forest, and wetland (or natural landscapes) because the potential for forest coverage is low in the oasis. We estimated the total area of natural landscapes was 20.14% based on a remote sensing study (Jiang et al., 2015). The composition of land use was: 6.17% of constructed land, 12.11% of desert, 62.58% of arable land, 4.23% of forest, 10.55% of grassland, and 4.36% of wetland in 2010. Arable land had been expanding while desert had been shrinking in the recent decade. This was because the intense water pumping and water policy that favoured agricultural expansion. Consequently, sustainability of the freshwater dimension was being threatened. We defined the safe boundary as preserving a minimum of 20% of land as natural landscape based on the government's goal stated in the 12th Five Year Plan. The percentage represented the normative value of local appreciation of natural landscape although the exact mechanism to quantify land-use change impact on local climate was uncertain (Geng et al., 2015).

2.1.4 Atmospheric aerosol loading

Aerosol loading, a form of air pollution, is harmful to human respiratory system. The impact of aerosol loading is elevated by the effect of regional monsoon (Steffen et al., 2015). Within our scope of study, aerosol loading was not a major concern. Instead, we indicated the air pollution dimension with particulate matter loading (PM10, particulate matter that smaller than 10 micro-meters in diameter) (Cole et al., 2014), which had immediate impact on China (Wang and Hao, 2012). The PM10 level in Zhangye was around 36 μg/m^3 based on local monitoring station. The safe boundary was set at 50μg/m^3 and high-risk boundary was set as 150 μg/m^3 (24-hours average) based on Chinese national air quality standards. Although the PM10 concentration differ over seasons, air pollution was not serious in the oasis, which was an agriculture based society.

2.1.5 Novel entities

The novel entities dimension is defined to quantify the impact of man-made chemical that exhibits characteristics of persistence, mobility across scales, and potential impacts on earth-system processes (Rockstrom et al., 2009). Due to various available candidates of chemicals (e.g. CFCs, nano-materials, plastic polymers), a universal global indicator has not been decided on within the PB framework (Steffen et al., 2015). At a regional scale, we represented this dimension with the usage of pesticides and herbicides, as agriculture was the main economic activities. We defined the safe boundary as no detectable pesticide and herbicide residue in the harvested crops. However, neither reliable data of residual level nor actual usage amount of chemical was publicly available.

2.2. Designing field survey for Regional Safe Operating Space

The downscaled PB showed the overview of the sustainability status of multiple environmental dimensions in the middle reaches of the Heihe River Basin. To understand how local perceived the environmental changes, and to explore the implication of transgressing the environmental boundaries, we conducted a field survey to interview the local residents from August 6 to 10, 2015. We targeted residents who had been living there for more than ten years. First, we selected twenty-one villages along Heihe River with an average distance of 10 km (see

Figure 1). In each village, we picked up two to three random respondents. We administered the interview accompanied by local Chinese students. The duration of the interview was about 15 minutes. A pilot study was conducted in Lanzhou before the actual field survey for testing the prepared questions. We improved the questions to minimize potential misinterpretations and ambiguities in the answers. In the middle reaches, our final sample size was 58 respondents. The gender distribution was 55% male and 45% female. The educational levels were: 38% primary school, 36% junior high school, 9% high school, and 17% had not receive formal education. Most of the respondents were over 40 years old (80%) and worked as farmers.

The interview consisted of four parts. In the first and second parts, we surveyed the local perception on how the five environmental dimensions (predefined from downscaling the PB) had changed in the past ten years and if livelihoods had changed correspondingly. These surveys were conducted to establish a background context (see S3.1 and S3.2 in Appendix A for details). The environmental dimensions were interpreted in plain language and local relevant description to facilitate the interview. The freshwater dimension, for example, was simplified as the perception of increase or decrease in water amount in the river. The livelihoods dimensions consisted of five categories: getting safe food, access to clean water, earning sufficient income, maintaining human health, and maintaining good relationship with neighbours. These categories were selected based on the priority shown in a global survey (Raworth, 2012). In the third part, we surveyed the local perception on environmental status (in section 2.2.1). And, in the fourth part, we investigated the potential environmental impacts on local livelihood (in section 2.2.2)

2.2.1 Local perception on environmental status

Social perception on the likelihood whereby a given environmental system would exceed its safe operating space was elucidated through the calculation of significant z-scores at an α level of 0.05 (z scores of values more than, or equal to ± 1.645) (Ebdon, 1985). Z-scores are an indication of how many standard deviations from the mean an observed perception score is, and functions as a common means of elucidating the significance of social perception on environmental or ecosystem services (Fagerholm et al., 2012; Van Dyck et al., 2013).

In the interview, respondents were asked to rank the possibility whereby each environmental category would exceed its sustainable operating boundary into three categories: “Not possible”, “Uncertain” and “Very possible” (see S3.3 in Appendix A for more details). The number of responses in each category was then assigned an ascending score (1 for “Not possible”, 2 for “Uncertain” and 3 for “Very possible”) in order to quantify the effect of the social perception of the likelihood that a given environmental system would become unsustainable in the near future. This score was then compared against a non-weighted mean, which assumed a respondent distribution in accordance with the assumption that every category corresponding to any given environmental system was equally likely to be selected. z-scores were subsequently calculated through elucidation of the number of standard deviations the observed score was from the non-weighted mean.

2.2.2 Potential impact on local livelihood

Transgressing environmental boundaries potentially results in the disruption of the local ecosystem, consequently impacting local livelihoods. We provided respondents five worst-case scenarios corresponding to the five environmental dimensions, and asked respondents how it might impact their livelihoods under each scenario in the open-ended questions to understand the implication of RSOS. We recorded the interviews and analysed the content following the principles of grounded theory (Strauss and Corbin, 1994), which the perceptions on environmental risks were analyzed without a priori hypotheses. We transcribed and identified the keywords mentioned by the interviewee, and then classified those keywords in five livelihood categories, i.e. food, water, income, health, and relationship with neighbors.

3. Results

3.1 Regional Safe Operating Space for the Middle Reaches of Heihe River

The result of RSOS assessment was summarized in Table 1 and plotted on a radar chart (Figure 3). Freshwater use was at a high-risk level; biogeochemical flow was uncertain; land-system change and atmospheric aerosols loading were conversely rated as safe. The novel entity category was defined but was not quantified at the moment due to the unavailability of data. We found that downscaling PB framework to RSOS was feasible to maintain the original intention and able to holistically cover the critical environmental dimensions in the local ecosystem.

Table1. Summary of the sustainability status and boundary definition for the regional safe operating space of the middle reaches of Heihe River.

Ecological Dimension	Regional Indicator (Control variable)	Boundary Definition	Boundary Value (Safe; high risk)	Current Value
Freshwater use	Water amount (m^3/year)	Water consumption exceeds water availability.	1.80; 2.25	2.39
Biogeochemical flow	Total nitrogen concentration in river (mg/L)	Nutrient concentration exceeds national water quality standards.	1.00; 2.00	1.49
	Total phosphate concentration in river (mg/L)		0.2; 0.4	0.2
Land-system change	Total coverage area of grassland, forest, and wetland (in %)	Natural landscape meets governmental goals.	20; 10	20
Atmospheric aerosol loading	PM10 loading ($\mu g/m^3$)	PM10 pollutant exceeds national air quality standard.	50; 150	36
Novel entities	Pesticide and herbicide residue	Pesticide and herbicide residue meets food standards	-	-

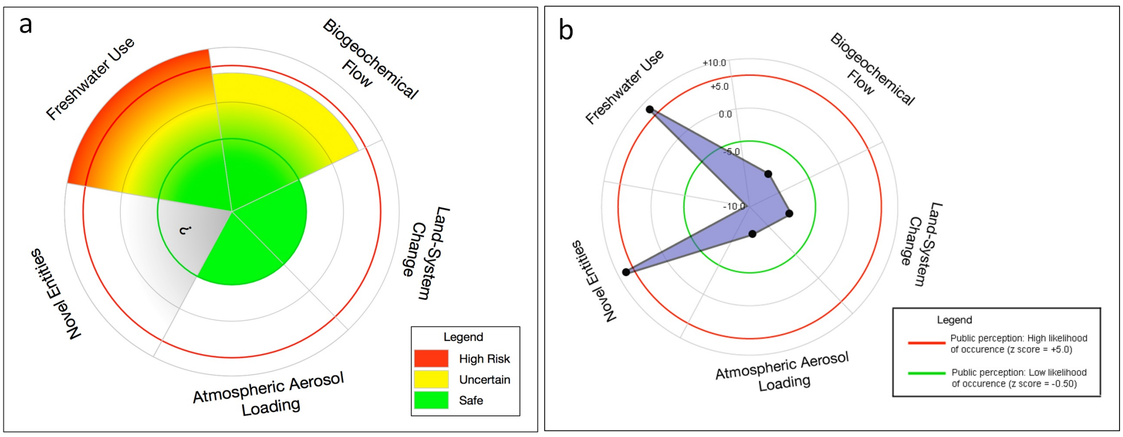

Figure 3. (a) Regional safe operating space of the middle reaches of Heihe River based on downscaling Planetary Boundary, and (b) local's perception on current status based on likelihood of occurrence of environmental disasters (standardized z-scores).

3.2 Local perception on current environmental status

Residents of the Heihe River basin responded to a questionnaire in which they were asked to rank the possibility whereby each environmental component assessed through the downscaling of the Planetary Boundary (Figure 3a) would exceed the RSOS. Normalized responses (z-scores) corresponding to the social perception on the likelihood of RSOS transgression were summarized in Figure 3b. Significant z-scores were classified as perceptions which corresponded to a high-likelihood of occurrence (z score > +1.645) or a low-likelihood of occurrence (z score > -1.645). Actual response percentages are summarized in Table S3.3 (Appendix A).

In general, perception trends (Figure 3b) corresponded to scientific trends in RSOS (Figure 3a). Notably, freshwater use was both perceived, and estimated to be likely to exceed RSOS boundaries, while atmospheric aerosol loading and land-system change were similarly perceived and measured to be within safe environmental operating zones.

We found that the unquantified factor (i.e. novel entities) within the scientific estimation of RSOS could be supplemented by on-the-ground knowledge from interview (i.e. perception of trends in using herbicide and pesticide). In accordance to social perception data, it might be concluded that local residents perceive herbicide and pesticide use to be at a level which might become environmentally unsustainable in the near future. There was also need for a closer examination of the relationship between data-based estimation of river nitrate and phosphate loadings and on-the-ground perception of nutrient levels in lakes, the former of which was rated as having an "uncertain" level of future risk, while the latter was perceived to be at a low-risk level.

3.3 Implication of transgressing safe operating space

We investigated how environmental changes would potentially affect local livelihood after evaluating the sustainability status. We used local perception to function as a gauge of the impact of environmental change at a social level (Table 2). More than half of the surveyed residents perceived that all environmental changes would have a negative impact on livelihood if they should exceed RSOS boundaries. In relation to the two environmental categories defined as most likely to exceed RSOS boundaries—freshwater use and novel entities—respondents were most concerned that the former would negatively affect their ability to obtain safe vegetables and fruits and to earn a decent income. 87% of the respondents were able to associate overuse of pesticides and herbicides with a definite negative health impact while slightly more than half (63%) correlated it with a decline in water quality levels.

Although the environmental component of atmospheric aerosol loading was not perceived to exceed safe RSOS boundaries in terms of social perception and biophysical data (Figure 3), it was one of the components evaluated by most of the respondents (91%) to have the most significant potential negative impact on livelihoods, specifically in the health department (92% of respondents). As such, it would be pertinent that this component be closely monitored in terms of future environmental impact surveys.

Table2. Summary of local perception on potential environmental disasters (of each ecological dimension) impact their livelihood, and the breakdown of livelihood impacts based on interview results (the numbers are shown in percentage).

Ecological dimensions	Having negative impact on livelihood	Breakdown of livelihood impacts				
		Getting safe vegetable and fruit	Getting safe drinking water	Earning enough income for living	Maintain good health	Maintain good relation-ship with neighbors

Freshwater use	0.79	1.00	0.78	1.00	0.18	0.87
Biogeochemical flow	0.72	0.78	0.78	0.78	0.49	0.61
Land system change	0.51	0.79	0.79	0.69	0.86	0.72
Atmospheric aerosol loading	0.91	0.23	0.25	0.17	0.92	0.19
Novel entities	0.91	0.29	0.63	0.13	0.87	0.13

4. Discussions

4.1 Complementing RSOS assessment with local perception

Data availability and data quality are unavoidable obstacles in performing RSOS assessment. In rural regions like the northwestern China and less-developed countries, it is impractical to rely solely on scientifically quantified data for environmental assessment purposes without sufficient regional data. Integrating social perception into environmental assessments has been recognized as a legitimate means of strengthening and ensuring relevance of biophysical approaches (Villamor et al., 2014).

In this study, we complemented RSOS with local perception and examined the credibility of this novel approach. We compared how RSOS assessment based on local perception differs to the result based on monitoring data in Figure 3a and 3b. Four out of the five environmental dimensions showed strong agreement, but not the biogeochemical flow, which locals perceived as safe instead of uncertain state. Two explanations were possible. First, the indicators of nitrate and phosphate concentrations in river water were not possible to distinguish by visual appearance (the visual discernment was only observable when eutrophication happened). Second, there were less lakes and slow flowing water in the middle reaches to observe local eutrophication. An advantage of perception survey was highlighted in the novel entities estimation. We were able to overcome the unavailability of monitoring data by using alternative survey result. We could surely presume that overuse of pesticide and herbicide had exceeded the safety boundary through the conversation with locals. Subsequently, followed up research should be conducted.

Although significant tendencies were statistically observed in all five risks perception survey, we were interested in further exploring the responses that disagree with the majority. Specifically, did the variation of local perceptions represent the actual differences of environmental status experienced in local communities (interview sites)? Or, was it simply a false perception? One example was looking into the freshwater availability. Respondents might perceive the water amount in the irrigation channel, which is managed and allocated by local authority, as natural river water due to the wide-coverage of irrigation system in the region. Therefore, we could not objectively distinguish the detailed water stress area and non-water stress area simply based on the responses.

4.2 Applicability and limitation of the study

We presented the RSOS result to the local government in Zhangye City, August 2015. The officers who attended the discussion included representatives from the environmental protection bureau, agriculture management bureau, city planning bureau, and water research institute. Overall, they were impressed with the simple and clear representation of RSOS (Figure 3a). But, there was no plan to apply the framework in actual policymaking process at the moment. We received feedback and updates on some timely ecological concerns. Particularly in novel entities, they pointed out a localized problem of excessive plastic mulch use due to the cold and arid climate. Farmers used the plastic mulch to reduce evaporation and reduce heat loss. However, there was no proper disposal of the plastic, causing pollution on the soil. This further illustrated that combining top-down and bottom-up approach can generate more local-relevant knowledge.

A limitation in this study was the exclusion of environmental dimensions that without local ecological threshold (e.g. climate change). This was not to suggest that they were unimportant in RSOS. However, we were aiming at exploring the value of local perception on estimating environment status, only ecological processes with noticeable impact by general public was considered so far. Alternatively, the survey could be extended to include questions, such as the perception of fair and just consumption to address those global dimensions (Nykvist et al., 2013). Finally, this research project was conducted under educational exchange program collaborated with Cold and Arid Regions Environment and Engineering Research Institute (CAREERI), Chinese Academy of Science (CAS). We, the authors, were invited as external researchers without prior in-depth understanding on local context.

5. Conclusion

In conclusion, this paper proposed a unique framework that combined top-down and bottom-up approaches to perform RSOS assessment. We highlighted the applicability of alternative knowledge, i.e. environmental risk perception of local inhabitants, to supplement the scientific knowledge, particularly when regional data is lacking. As such, the assessment framework is practical for decision makers and expandable to developing countries (where scientific monitoring can be expensive). We applied the framework in the case study of the middle reaches of Heihe River. Our results implied that due to intense human development Heihe River Basin had been transgressing its safe operating space, specifically was high risk of freshwater use, and uncertain in biogeochemical flow and novel entities. The downscaled indicators for sustainability assessment based on PB holistically alerted the local stakeholders about their impact on all dimensions of ecological boundary.

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Appendix A – Supplementary Materials

This document provides the supplementary materials for supporting the paper entitled "Downscaling Planetary Boundaries to Semi-Arid Ecosystem: An Assessment with Local Perception in Middle Reaches of Heihe River Basin".

S1. Groundwater level in Ganzhou and Linze

An impact of excessive freshwater use is the depletion of groundwater. We collected monthly groundwater level data at multiple villages in the district of Ganzhou and Linze, which are in the scope of this study. We show a clear decreasing trend of groundwater level in villages, including DAM and WQZ, for the past few decades. The trends are categorized as high-risk based on Dearling et al. methodology(in type-2, non-linear pattern) [1] since the rate of change is rapid.

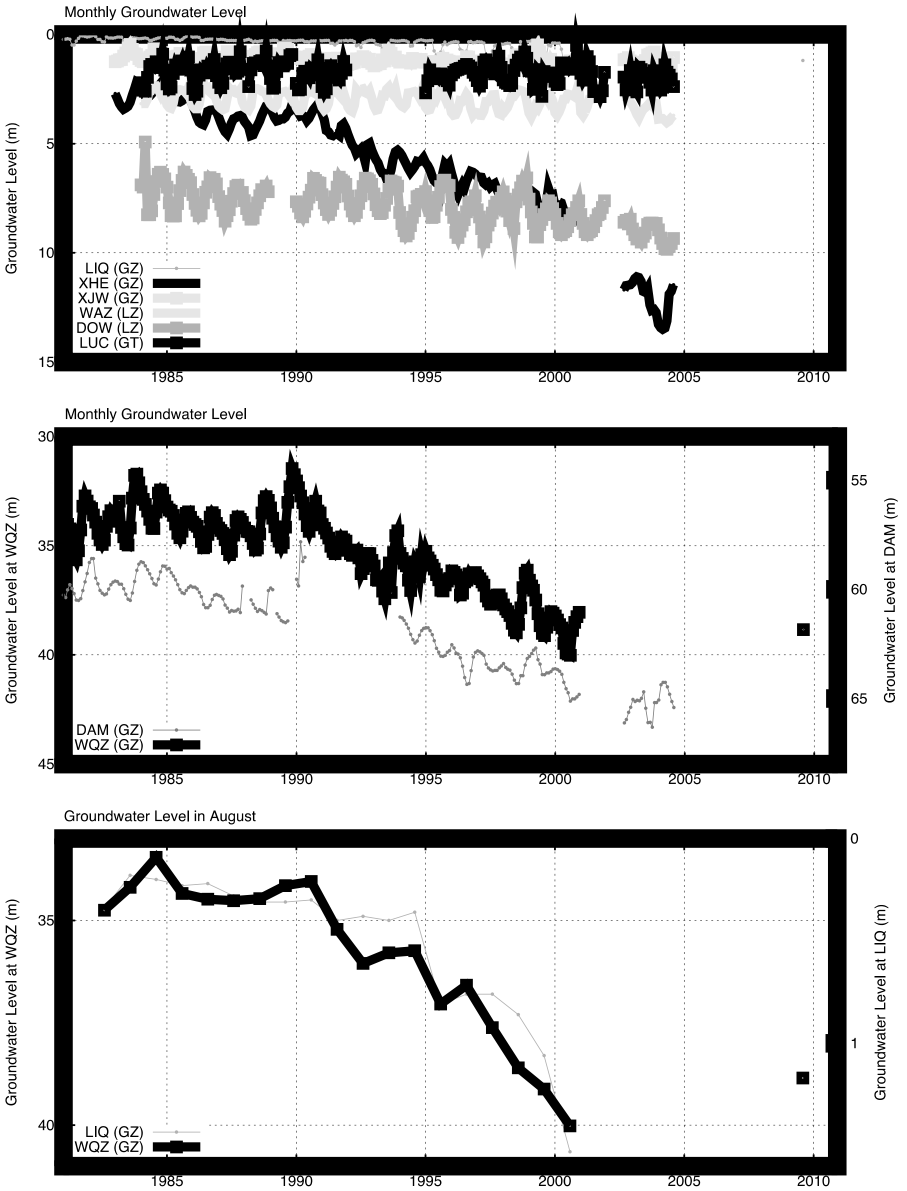

Figure S1. Groundwater level in selected villages in the study area.

S2. Nitrate concentration in groundwater

Excessive use of nitrate fertilizer may infiltrate to groundwater and elevate the nitrate concentration. High nitrate level in drinking water has potential health impact on human. We show the concentration of nitrate in seven wells in the study area. The nitrate pollution is observed in some samples where the concentrations are significantly higher than others.

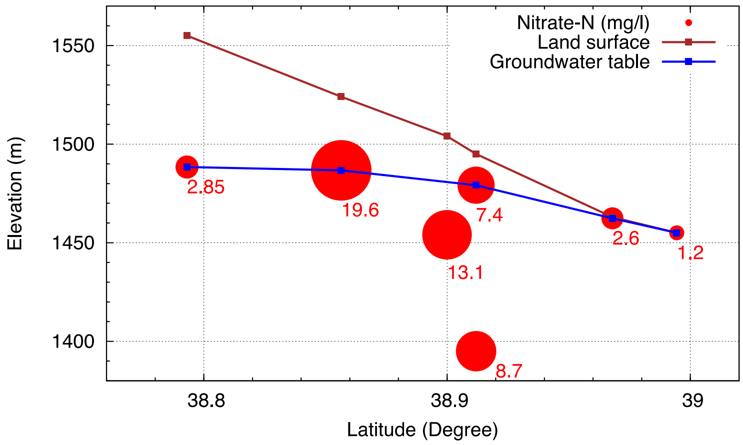

Figure S2. Nitrate concentration in selected water wells in the study area.

S3. Additional content on field survey

The field survey was designed in four parts, which first and second parts were about the background survey (excluded in the paper), and the third and fourth parts were the main interests. Here, we showed the survey and results for the first and second parts. These were explorative studies. The results were showed in descriptive manner. Further analysis might elucidate possible relations and differences between perceptions in different locations in the study site.

S3.1 Livelihood changes in the past 10 years

First part of the survey asked respondents to rate the changes in their livelihood in the past ten years in Likert scale. The results were summarized in Table S3.1. Most respondents agreed that the livelihood was improving, especially on getting safe food and access to clean water. The conflicts with neighbors had been improving with better water management to prevent water grabbing.

Table S3.1. Livelihood changes in the past 10 years based on field survey.

	very easy	easy	no change	difficult	very difficult	NK/NA	
1.1 Getting safe vegetable and fruit	51.7%	22.4%	5.2%	8.6%	8.6%	3.4%	100%
1.2 Getting safe drinking water	50.0%	24.1%	12.1%	6.9%	6.9%	0.0%	100%
1.3 Earning enough income for living	39.7%	32.8%	17.2%	6.9%	3.4%	0.0%	100%
1.4 Maintaining good health	39.7%	32.8%	6.9%	10.3%	8.6%	1.7%	100%
1.5 Maintaining good relationship with neighbors	44.8%	17.2%	17.2%	12.1%	8.6%	0.0%	100%

S3.2 Environmental changes in the past 10 years

Second part of the survey asked respondents to rate the changes of environment, particularly on the five dimensions defined in our regional safe operating space. Most of respondents perceived that water amount of Heihe River had increased. Although such finding seemed to be contradicting to the hypothesis of freshwater was under pressure, the review of water policy showed that aggressive management had been taken place since 2000s [2] and may be the effect of such policy. Most respondents perceived that both water and air quality had deteriorated or remained the same. Remarkably, most respondents perceived the use of pesticide and herbicide had increased a lot. Wetland area had been decreasing.

Table S3.2. Environmental changes in the past 10 years based on field survey.

		Increase A lot	Increase	No Change	Decrease	Decrease A Lot	NK/NA	
2.1	River water amount	22.4%	24.1%	24.1%	8.6%	6.9%	13.8%	100%
2.2	River water quality	10.3%	8.6%	36.2%	22.4%	10.3%	12.1%	100%
2.3	Air quality	12.1%	13.8%	31.0%	29.3%	10.3%	3.4%	100%
2.4	Pesticide use in the area	56.9%	15.5%	10.3%	13.8%	0.0%	3.4%	100%
2.5	Wetland area in the region	6.9%	15.5%	17.2%	19.0%	27.6%	13.8%	100%

S3.3 Social perceptions on the likelihood of transgressing the environmental boundaries

We showed how local perceive the likelihood of transgressing the environmental boundaries in Table S3.3. The results were processed and represented in z-score in the paper.

Table S3.3. Social perceptions on the likelihood of transgressing the environmental boundaries on field survey.

		Not Possible	Uncertain	Very Possible	
3.1	River water amount decrease a lot	22.4%	39.7%	37.9%	100%
3.2	River water quality becomes bad	41.4%	34.5%	24.1%	100%
3.3	Air quality becomes bad	44.8%	31.0%	24.1%	100%
3.4	Overuse of pesticide/herbicide	20.7%	27.6%	51.7%	100%
3.5	Wetland, grassland and forest reduce a lot	55.2%	24.1%	20.7%	100%

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Developing a new theoretical framework for the Index of Sustainable Economic Welfare (ISEW)

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Abstract

The ISEW is one of the indicators that have assumed a relevant role in the discussion of alternatives to the GDP. Developing a broad consensus on the conceptual and methodological aspects of the indicator is a fundamental step to improve the validity, acceptance and policy relevance of the ISEW. It is intended that the ISEW can represent a viable alternative or complementary leading indicator in the evaluation of a countries welfare and sustainability performance. The indicator should also be capable of implementation and use by different stakeholders such as policy and decision makers, international organizations, businesses, citizens, NGO's, among others. For this purpose a new theoretical framework for the ISEW is proposed which can provide a clearer picture of the trends of a country's welfare levels as well as the success of policies implemented. The changes introduced also allow for a direct comparison of the results of the ISEW with those of the GDP, which are advantages over other studies.

In this work empirical applications are developed to two countries with different socio-economical patterns, Portugal and the USA. The results obtained for the ISEW evidence a significantly different behaviour when compared to the GDP. For both countries, the significant increase of the GDP is not matched by the ISEW and there are periods where the two indicators have a different behaviour. This challenges the dominant paradigm, which assumes that a GDP increase will lead to a general improvement of welfare.

These results can provide some suggestions for policy and decision making. The traditional use of GDP to support policy strategies, to make international comparisons, or to evaluate changes in welfare, is constrained by important and acknowledged limitations. The misevaluation of the contribution of environmental and social issues, present in the dominant paradigm, may contribute to a biased perception of policy and decision makers. For example, social measures oriented towards improvements in health and education may not have a significant effect on the GDP, but may have a substantial influence on an indicator such as the ISEW. Therefore, decisions made mainly on the traditional paradigm, that an increase in GDP lead to an improvement in welfare may be biased and based in incomplete information. The measurement of welfare and sustainability can benefit significantly from the development of alternative indicators, which are able to encompass the situation and trend of economic, environmental and social aspects in an integrated evaluation.

Indicator-based strategic-level sustainability evaluation for coal mining plan alternatives

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Abstract

Strategic-level analysis is considered to be the efficient way of mitigating the potential negative impacts while enhancing the potential benefits of future plans and investments, especially in the field of natural resource management. Thus, strategic-level analysis contributes to better management of non-renewable resources like coal mining, as it provides mining sector with operations in terms of sustainability priorities. Regarding this, an indicator-based strategic-level sustainability evaluation framework is introduced as a decision support tool in this paper. In order to do this, priorities of sustainability in the mining sector and the inventory of the mining sector related sustainability indicators for the strategic- and project-levels are analyzed. The introduced framework is implemented for contributing to the energy policy and to the local sustainability criteria with the selected mining sector related sustainability indicators in a case study for the coal mining plan alternatives in the Afşin-Elbistan Coal Basin (AECB) in Turkey. As a result of the assessment, the results indicate that no-action alternative should be selected for both the energy policy and also the local sustainability criteria focused evaluation unless the land degradation, land expropriation and resettlement related problems would not be overcome while planning the mining sector operations in the AECB.

Keywords: Sustainability assessment, Mining sector, Sustainability indicators, Analytical Hierarchy Process, Land degradation

1. Introduction

Investments in the mining sector must be practiced in regions where the natural resource is located. Positive and negative impacts on environment, society and economy emerge as a result of these investments. The continuity along the time, the affected area and the intensity of these impacts depend on the characteristics of the project, i.e. surface or underground mining, labor intensity, and the project implemented region (Bell and Donnelly, 2006).

The disturbance of wide surface areas, the destruction of original vegetation, changes in original topography, issues of land acquisition and resettlement, deforestation and visual deterioration are few examples for the surface mining impacts (Dontala et al., 2015).Generally, such environmental and visual impacts cause the conflict between the mining sector and the public. This is especially pronounced for the surface mining operations as their physical impacts are visible and wider due to increased amount of land disturbance (Chikkatur et al., 2009).

The land disturbance in the mining sector is relatively larger. For example, size of the soil moved from one point to another by the mining sector is significantly higher than any other human-sourced actions (Kirsch, 2009). Additionally, it is given that the total gross material mass that was moved due to the surface mining operations, including overburden and mass, increased by 48% from 1975 to 2000 (Douglas and Lawson, 2005). Hence, the land disturbance becomes much larger than the amount of exploited reserve itself (Azapagic, 2004). More specifically, Douglas and Lawson (2005) give the example of coal (hard, brown and lignite) mining, which caused 47% of the total gross material movements among all the other mineral excavations in 2000.

Therefore, the integration of sustainability principles into decision-making with sector-specific frameworks is highly essential for the mining sector. However, as Kirsch (2009) criticizes, the mining companies and governments use the terms like ‘clean coal’, ‘social responsibility’, ‘transparency’, ‘sustainable mining’, and ‘conservation projects and auditing’ to compensate harm and neutralize the critics. Therefore, without the quantification or operationalization of the sustainability into impact assessment approaches successfully, the obtained results would not be considered more than “some green-washing of big business/investments and the use of sustainability concepts could not go further than academic discussions” (Vanclay, 2010, p.106).

Although these studies consider that the concept of sustainability is used as a ‘marketing’ feature, and they found that it conflicts with the mining activity, the complexity of integration and operationalization of sustainability into decision-making process minimizes th negative impact. According to Ridder et al. (2010, p.126) argues that “the overlapping and conflicting priorities, value systems, complexities of interlinked systems and sectors, make planning and analysis for more sustainable policies a difficult and complex issue”. Additionally, the lack of actual methodological and analytical guidance about integrated assessment tools, problems faced during actual practice of integrated assessments are the major issues to be tackled (Ridder et al. 2010).

Therefore, understanding the sustainability concept and measuring the level of sustainability of current and planned operations and strategies are needed for the mining sector. Additionally, the systematic, objective and transparent analysis of the strategies of the coal mining sector in terms of the sectoral sustainability concept contributes to avoid irreversible unsound planning and potential social conflict and to prevent using the term of sustainability as green-washing practice for social license to operate. In this respect, an indicator-based strategic level sustainability evaluation framework as a decision support tool is introduced in this paper. In order to do this, priorities of sustainability in the mining sector and the inventory of the mining sector related sustainability indicators for the strategic- and project-levels are analyzed. The introduced framework is implemented with the selected mining sector related sustainability indicators in a case study for the coal mining plan alternatives in the Afşin-Elbistan Coal Basin (AECB) in Turkey.

1.1. Strategic-level and project-level evaluation

In order to operationalize and integrate the sustainability criteria into decision-making effectively, the focused level of the assessment becomes an important parameter. Starting from the early 1970’s, different tools have been used by decision-makers and investors for mitigating and/or minimizing the negative impacts while increasing the positive outcomes of such investments. Among these tools, the one that was most widely used and studied is the Environmental Impact Assessment (EIA) (Vanclay, 2010).

EIA has become a mandatory tool in developed and most of the countries in transition as a result of the discussions on sustainable development with the first Earth Summit in Rio in 1992 (Lee and George, 1999). However, there are insufficiencies about the project-level assessment and evaluation. Firstly, since the project-level tools, i.e. the EIA, aim to mitigate and minimize the negative environmental impacts of a specific project, they have a limited capacity in considering and integrating the three pillars of sustainability (environmental, social, economic) into decision-making equally. Therefore, motivation to use integrated approaches to overcome this issue rises globally (Vanclay, 2010).

Secondly, the project-level assessment tools focus on a single targeted project at a time and discuss it in detail with a comprehensive analysis. However, all the strategic decisions have already been given before the project scale, so consideration of the strategic-level alternatives cannot be possible in practice (Wood, 2003). In this respect, early practicing tools and frameworks are necessary for evaluation and comparison of the sustainability of the alternatives in order to inform the decision-makers about the different outcomes of possible alternatives; to mitigate the approval of sustainably unsound projects in the future; and to operationalize the concept of sustainability in practice.

Strategic Environmental Assessment (SEA) is one of the tools for evaluation and comparison of the strategic alternatives with an EIA-based process in terms of environmental pros and cons by developing an environmental report. EU Directive on SEA (2001/42/EC) provides a well-defined procedure for evaluating the likely significant effects on the environment and the reasonable alternatives of the proposed strategies (European Commission, 2015). Figure 3 summaries the assessment of sustainability with various copes and priorities.

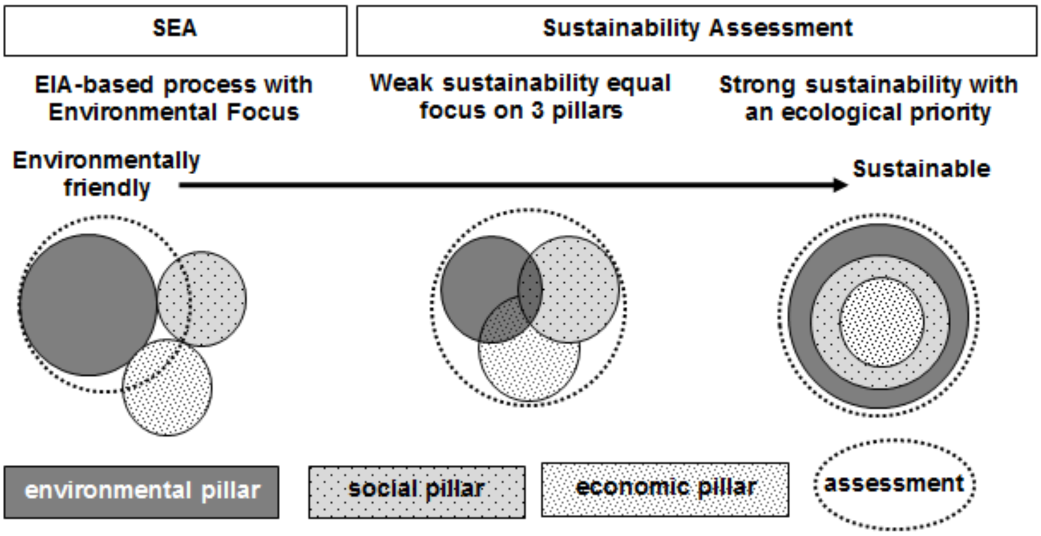

Figure 3. Assessment of sustainability with different scopes and priorities (Yaylacı, 2015)

SEA, based on the EU Directive, primarily focuses on the environmental pillar. Different than SEA, when the three pillars are equally integrated into the assessment, it is categorized under the sustainability assessment (SA) (Figure 3). In fact, based on the discussions, given by Kirsch (2009), weak sustainability and strong sustainability concepts are used for categorization of the SA in terms of its priorities in Figure 3 (Yaylacı, 2015). Weak sustainability involves the evaluation process with the consideration of three pillars and their interactions equally. Therefore, weak sustainability indicates “human-centered” rather than “conservation-centered” focus (Kirsch, 2009). The strong sustainability, on the other hand, includes the evaluation process should consider the three pillars without trading the ecological priorities with social and economic benefits in the evaluation process (Kirsch, 2009).

The use of the framework, proposed by Yaylacı (2015), is adopted in this paper for evaluating the sustainability levels of coal mining plan alternatives in terms of weak- and strong-sustainability focuses at the strategic-level. Moreover, the evaluation of the alternatives is conducted with the indicators. In order to perform the evaluation at the strategic-level, the indicators must be also applicable at and suitable for the strategic-level evaluation. For this purpose the characteristics of project-level and strategic-level assessments should be clarified. In this regard, the comparison of the characteristics of these two levels of assessments is given in Table 5.

1.2. Mining and sustainability

It is argued that the mining sector has highly conflicting characteristics with the concept of sustainability (Kirsch, 2009) and therefore defining sustainability within the context of mining is still challenging (Hilson and Basu, 2003). Additionally, using the sustainability concept for the mining sector is criticized in two ways. First, the concept is diverted from its original reference to ecology (Kirsch, 2009). Second, it is transformed the original concept from “conservation-centered” (strong sustainability) to “human-centered” (weak sustainability) by referring primarily to economic variables under the phrase of sustainable development (Kirsch, 2009, p.91). According to Kirsch (2009) environment must be independent from human economies and these should not be traded as interchangeable in a sustainable system.

Table 5. Characteristics of project-level and strategic-level assessment (Yaylacı, 2015)

Criteria	Characteristics of	
	Project-Level (PL)	**Strategic-Level (SL)**
Objective	Decision-making with full knowledge of a project's likely significant environmental effects, and that any negative effects are prevented, reduced or offset, while positive effects are enhanced	Decision-making with the integration of environmental considerations into the preparations and adoption of plans and programs with a view of promoting sustainable development
Scope	• What are the main characteristics of the projects? • Where is it located? • What are project alternatives? • What are its main physical, social, economic effects? • What are its major impacts? • What are the mitigation measures?	• What are the objectives of decision-making body? • What are key drivers? • What are strategic options? • What are key restrictions? • What are major interests? • What are the most important policies to be met?
Scale	Considered impacts: Micro scale, mostly local Considered time: medium to short term	Considered impacts: Macro scale, global, national and regional Considered time: long to medium term
Alternative consideration	Specific alternative locations, design, construction, operation	Spatial balance of location, technologies, fiscal measures, economic, social or physical strategies
Tools and techniques	Depends on the specific case and mostly quantified. Examples of tool and techniques: field surveys for data collection, overlay-mapping, life-cycle assessment, cost-benefit analysis, multi-criteria analysis	Quantification of assessment is more difficult due to greater degree uncertainty but quantified approaches also possible. Examples of tool and techniques: forecasting, scenario analysis, multi-criteria analysis, mathematical modelling

However, it must also be considered that all of the human actions have impacts on the environment and therefore trade-offs are inevitable. Therefore, one of the criteria for preventing the conflicts between sustainability and the mining sector should be avoiding the lack of understanding the significant negative consequences of potential trade-offs. This can be overcome based on obtaining clear, comparable and assessable information during the decision-making. While doing this, the trade-offs must be clearly defined and the criteria on how to deal with them should be identified. Gibson (2006b) suggests two approaches. The first one is defining the general rules to decide what types of trade-offs may be acceptable and what others may not be acceptable. The second one is consulting with the stakeholders to discuss if the proposed trade-offs are reasonable. In this study the second approach was adopted for understanding the local priorities and acceptable trade-offs.

Besides, there are counterintuitive conditions of the mining sector and sustainability as the mining sector is dealing with a limited non-renewable resource mostly in remote and/or environmentally sensitive locations that causes significant environmental degradation. Despite counterintuitive conditions of the mining sector and sustainability, the mining sector is under pressure to reduce the local negative impacts and risks to guarantee the local benefits for long terms in order to gain social license to operate, re-build its reputation in regulatory and investment cycles globally (Laurence, 2011; Giurco and Cooper, 2012; Worrall et al., 2009, Gibson, 2006a).

In addition to negative environmental impacts, as the actions are depending on the limited non-renewable resources, once the natural resource depletes, all the social and economic benefits disappear after the mining sector leaves the region. As a result, it is claimed that the mining sector does not provide long-term benefits, especially for local communities, in a sustainable way

(Lins and Horwitz, 2007, p.13). Hence, the sector must consider the long-lasting and fair distribution of the well-being where it operates in order to invalidate the arguments on using the term as marketing concept for obtaining social license to operate. Accordingly, the second criteria, considered under sustainability and the mining sector discussions in this study is determined as creating long-lasting social well-being at the local and strategic-levels.

In spite of controversial issues related to mining sector and sustainability, the increased energy demand in the world as well as safety issues emerged for nuclear power facilities after the Tohoku Earthquake, still increases the coal mining activities. Hence the mining sector needs methods for evaluating and comparing its plans, programs and projects and their alternatives in terms of sustainability criteria. In order to do this, the sustainability criteria for comparing the actions of the mining sector can be summarized for this study as;

- creating a long-lasting social well-being,
- obtaining comparable information on possible trade-offs and their consequence, and
- achieving natural resource efficiency for balancing costs and benefits (including the protection of ecosystems and contribute to long-lasting well-being)

1.3. Indicators for strategic- and project-level sustainability evaluation

Indicators are one of the core parameters of the proposed framework for evaluating the sustainability levels of plan alternatives in the mining sector. In fact, there are several studies and initiatives conducted for evaluating and measuring the sustainability in the mining sector. For instance, the Coalition for Environmentally Responsible Economies (CERES) and the Tellus Institute initiated the Global Reporting Initiative (GRI) provided a systematic approach to measure the sustainability levels of the companies and their actions systematically (Yaylacı, 2015).

Similarly the Mining, Minerals Sustainable Development (MMSD) Project, initiated in 2000 by Global Mining Initiative (GMI) in order to maximize the contribution of the mining sector to sustainable development at the global, national, regional and local levels. Also the International Council on Mining and Metals (ICMM) published 10 sustainability principles for its global mining company members in 2003. ICMM and GRI joint working group published the Mining and Metal Sector Supplement of second version of GRI guidelines in 2003 as the basis of reporting the economic, environmental, human rights and social performances of ICMM member mining companies with the specific performance indicators (Yaylacı, 2015).

These might be seen as the milestones in the sustainability and mining sector discussions and actions. However, in most of these, e.g. Warhurst (2002), Azapagic (2004), the focus is the company/project level evaluation of the sustainability in the mining sector practices for a specific company and/or for specific project(s). However, there is a need for assessment at the strategic-level, which focuses on the likely significant effects of the proposed/revised strategy and its reasonable alternatives. Therefore, an inventory of the available indicators, given in the literature, should be established in order to obtain a strategic-level indicator set, fitting in the characteristics of strategic-level assessment.

For this purpose, first a global indicator set, including 323 indicators, is developed. Then, these indicators are classified under environmental, social and economic indicators sets with 146, 131and 46 indicators in each group, respectively. Moreover, Yaylacı (2015) suggests additional 13 social and 11 economic indicators specific to the site. As a result, the global indicator set has 347 sustainability indicators, related with the mining sector. The distribution of the indicators under environmental, social and economic pillars can be seen in Figure 4.

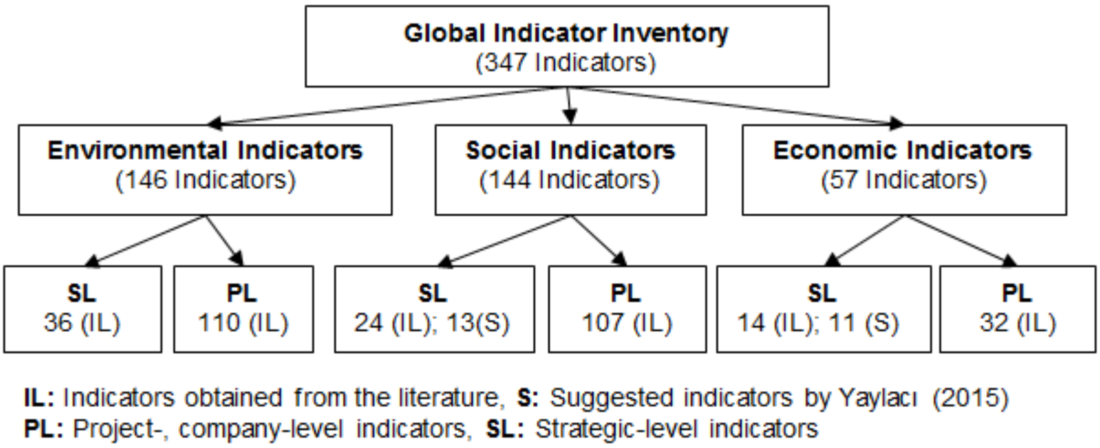

Figure 4. Inventory of the sustainability indicators for the mining sector (Yaylacı, 2015)

The classification of the indicators in terms of strategic- and project-level is conducted by Yaylacı (2015) based on objective, scale, scope and alternative, possibly discussed within the assessment, criteria (Table 5). As a result of this classification, the final environmental, social and economic indicator sets, applicable at the strategic-level sustainability evaluation, is obtained with 36 environmental indicators, 37 social indicators and 25 economic indicators (Yaylacı, 2015).

2. Method and Material

The proposed framework and its methodological steps is shown in Figure 5. The framework involves nine application steps, six screening criteria, which are used for elimination of different options at the application steps and different applicable methods while applying the nine steps (Figure 5). The first methodological step of the sustainability evaluation is determination of the objective of the strategy, which is planned to be practiced or revised. The objective of the strategy indicates the potential and aimed direction behind the proposal or revision on the focused strategy. Therefore, higher level, such as global, country-specific and other related policy interactions should be considered as the screening criteria.

When the strategic objective is determined, the scope and also targets of the evaluated strategy can be established (Step 2). The main objective of this step is to understand what is aimed to be achieved in which limits of the focused sector and area/region. If these are clearly determined as early as possible, outcomes of the evaluation are expected to be more satisfactory. Additionally, as it can be seen in Figure 5, clear understanding and determination of the scope and targets (Step 2) positively affect the determination of sustainability criteria (Step 4) and alternatives (Step 5) because Step 2 is highly interacting with Step 4 and Step 5.

Determination of sustainability concept for the specific sector is the third step in the framework, given in Figure 5. For this study as the focused sector is the mining sector, the sustainability concept is discussed within the mining sector based on the available discussions in the literature. The discussion and obtained conceptual sustainability framework is given in Section 1.2.

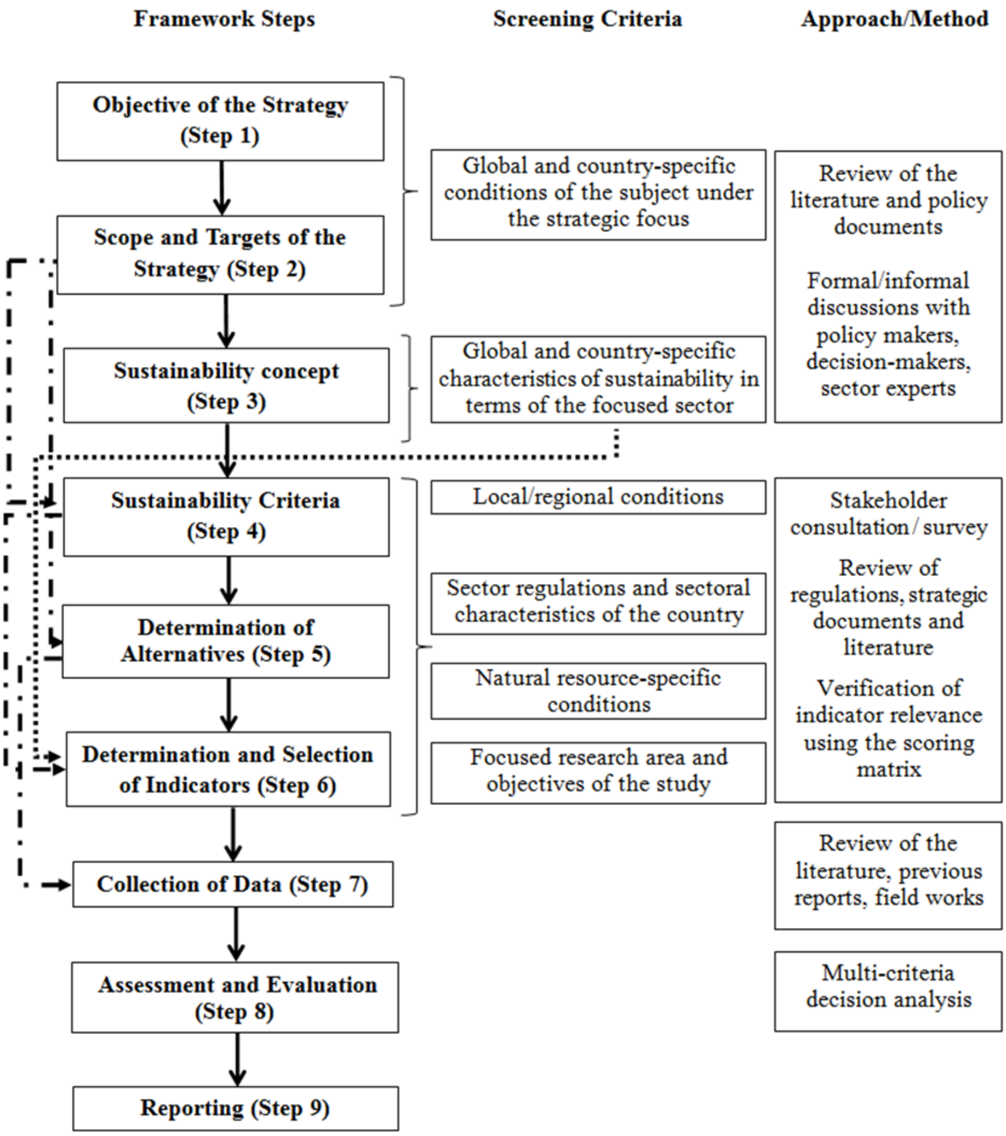

Figure 5. The proposed indicator-based sustainability assessment framework

However, due to the significant differences between the sustainability concepts in project and strategic levels, the proposed framework under this study also practice a scoping for the mining and sustainability concepts in terms of national-level strategic priorities and local-level expectation and needs. This is called determination of sustainability criteria in this study and given as the fourth step in Figure 5. Without such a study-specific scoping, or determination of sustainability criteria (Step 4), indicator selection and alternative consideration will not possible to obtain reasonable results in terms of sustainability.

The fifth step of the proposed framework is the determination of alternatives. The alternatives should

- achieve the strategic targets and meeting the limitations of the scope of the study while considering the 'either-or' and 'mix-and-match' options (extended from João, 2005, p.8);
- fit into the stakeholder concerns; local and sectoral characteristics that determine the sustainability criteria;
- be realistic and applicable in practice and also assessable in terms of available finance, expertise and time.

The strategic-level assessment should focus on alternatives and the first alternative for any strategic-level assessment, i.e. Strategic Environmental Assessment (SEA), is expected to be the 'no-action' alternative (João, 2005). Hence, the developed framework also suggests the 'no-action' alternative as the first alternative to be considered. 'No-action' alternative under the discussed framework reflects consideration of the current conditions as they are and implementation of the assessment step for these conditions.

Moreover, the alternatives should be also determined by considering the sectoral characteristics in the county, including the investment environment, regulations, the qualification and capacity of employees, accessibility to financial resources and technology. In addition, the characteristics of the natural resource as well as the study-specific objective and scope are significantly important parameters that must be considered while determining the alternatives.

The sixth step of the sustainability assessment framework is the selection of the indicators that are used for the assessment of the plan alternatives. As it can be seen in Figure 5, the indicator selection is highly interacting with determination of sustainability criteria and selection of alternatives steps, which are Step 4 and Step 5, respectively. This is because; the selected indicators must be technically capable of evaluating the determined alternatives in terms of the sustainability criteria.

The selection of the indicators should be conducted systematically to minimize the number of irrelevant indicators and potential management difficulties (Graymore et al., 2008). Therefore, the total number of selected indicators is an important factor for avoiding time-consuming and ineffective assessment processes. In this regard, it is suggested that using 20 indicators in an assessment is reasonable in order to have a manageable number of indicators while preventing having too few, which causes exclusion of the important information, and having too many to face time and data obstacles (Moles et al., 2008).

As a result, the selection of the indicators is conducted with a scoring matrix for making the process as systematic and objective as possible. The parameters, given below, are used for scoring the strategic-level indicators,

- **Scope:** Selecting the indicators that fit into the scope and targets of the studied strategy and the focused sustainability issues (extended from Mascarenhas et al., 2015).
- **Relevance:** Selecting the most suitable indicators for the specific study subject (extended from Mascarenhas et al., 2015; Oudenhoven et al., 2012).
- **Data availability:** Indicating the accessibility of the data.
- **Quantification:** Considering the quantification capacity of an indicators as a selection parameter instead of trying to use indicators with thresholds or reference values for making comparison.

For the scoring matrix, a three-level scoring is used as low (score of 1), medium (score of 2), and high fulfilment (score of 3) of the respective parameter. Score of 0 is given for 'not applicable' or 'no idea' cases. For this study, the indictor selection is conducted in two steps. The first one is completed by the authors for eliminating the indicators based on the data availability or quantification capacity. Therefore, 16 out of 36 strategic-level environmental indicators, 22 out of 37 strategic-level social indicators and 10 out of 25 strategic-level social indicators are obtained. In the second step, 16 environmental, 22 social and 10 economic indicators are scored by an external group of individual experts, who are actively working in the field of mining and natural resource management. The scoring for this study is asked to be conducted based on the scope and relevance parameters.

Regarding the scope parameter, the focused strategy and its targets, stressed by the Ministry of Energy and Natural Resources (MoENR) and announced by the Ministry of Development (MoD) of Turkish Republic are considered (MoD, 2013). As a result, the scope of the indicator selection is determined as exploitation strategy of MoENR for the lignite reserves, which aims at increased recovery and use of the domestic primary energy resources within the primary energy resources in Turkey.

The relevance parameter for the indicator selection is determined based on the concerns and expectations of the local stakeholders, who live in the studied basin permanently and more than five years at the time of study. These are formulized as the local sustainability criteria via focus group meetings, face-to-face discussions and a survey with 1008 participants in the focused region

(Düzgün et al., 2015). As a result of these field works, three local sustainability criteria are given by Düzgün et al. (2015) as;

- To minimize and mitigate the air quality problems, sourced from the thermal power plants;
- To minimize and mitigate extensive land use for the mining operations that causes problems, including land acquisition, resettlement, change in the traditional economic activities, and
- To maximize employment of the locals in the mining sector, primarily the youngsters from the land owned families in the license area.

Among these, due to the data limitations, only one of them is focused as the relevance parameter for the indicator scoring that is minimizing and mitigating the extensive land disturbance due to the mining operations. In addition to the indicators, the experts are also asked to determine the importance of economic, social and economic pillars in the calculation of final sustainability score of the alternatives by considering the weak and strong sustainability concepts. For this purpose, UN's (2015) definition on weak and sustainability is considered. The weak sustainability is defined as "the total value of the aggregate stock of capital should be at least maintained or ideally increased for future generation"(UN, 2015). The strong sustainability, on the other hand is given as "conserving the irreplaceable stocks" (UN 2015).

For scoring the indicators, 23 experts are contacted. Nine of these are academicians and researchers in the field of environmental planning and natural resource management. Among these nine, three of them are working for national and international non-governmental organizations. Four of them are working at a university and research institutions. Two of the nine are working in auditing and consulting organizations.

13 of the contacted experts are mining engineers and one is geological engineer, who are working in the mining sector at least five years. Among this group, five of them have a PhD degree in mining engineering and four of them are working in the mining sector at the planning and managing levels within national and international mining companies more than five years. Also one of these is a professor at a university in Turkey. Additionally, three of the participants are also working at a university as a researcher or instructor in the departments of mining and geological engineering. Five of the contacted experts are working at the different levels from senior engineer to general manager in the mining sector. One of the mining engineers is working for the government at a high level decision-making position in the energy and natural resources decision body in Turkey.

Among 23 contacted experts, 14 of them provided the fully conducted scoring and indicator selection matrices. As a result of their scoring, two groups of indicator sets are obtained under the environmental, social and economic pillars. The first group of indicators is selected for the assessment of the alternatives based on the security of energy supply focused strategical priorities. These are given in Table 6-4 for environmental, social and economic indicators, respectively.

Table 6. Final environmental indicator set for the energy based assessment

ID	Indicator	Unit	Impact
E1	% of resource is left relative to the total amount of the permitted reserves of that resource*	%	-
E3	Amount of land disturbed or rehabilitated due to mining operations	ha	-
E11	Number of sites on environmentally protected or sensitive areas, including both current and planned developments	number	-
E14	Area change from greenfield to brownfield	ha	-
E15	Total waste extracted (non-saleable material, including overburden)	m^3	-
*The original indicator is needed to be transformed to negative impact as all the other selected indicators in the set indicate negative impact conditions			

Table 7. Final social indicator set for the energy based assessment

ID	Indicator	Unit	Impact
S3	The number of households resettled due to proposed developments (Displaced population)	number	-
S13	Net income change per capita* (before/ after mining in the region)	%	-
S14	Total new land acquisition** (due to the mining operations)	ha	-
S18	Percentage of local population think/ observe the mining sector as potential source of conflicts on the local level in terms of environmental issues, including land use and land acquisition	%	-
* If the net income has raised after the mining in the region, the change need to be given as a dominator of 1 in order to fit in the negative impact effect of the set. ** Contrary to economic indicator set, land acquisition is seen as a negative impact in the social set in this study because most of the purchased land is agricultural land and it is an important local economic activity of the locals. The applied questionnaire shows that local communities see land acquisition as a negative impact on their society.			

Table 8. Final economic indicator set for the energy based assessment

ID	Indicator	Unit	Impact
Ec1	Amount of sellable product production	tonnes	+
Ec2	Earnings from all sellable products based on today's market price before interest and tax	monetary unit	+
Ec3	Value-added per unit value of extracted reserve	monetary unit/tonnes	+
Ec10	Recovery of reserve (ratio of alternative's tonne / estimated tonne)	%	+

Besides the energy focused assessment, the alternatives are also evaluated based on the local sustainability criterion. The participants of the indicator scoring are asked to consider the one of the locally determined criteria, which is minimizing the land disturbance caused from the mining sector operations, while scoring the indicators under environmental, social and economic pillars. Consequently, the indicator sets that are used for evaluating the three alternatives in terms of local sustainability criterion are obtained. These are given in Table 5-7, as the environmental, social and economic indicators sets, respectively.

Table 9. Final environmental indicator set for the local sustainability criteria based assessment

ID	Indicator	Unit	Impact
E3	Amount of land disturbed or rehabilitated due to mining operations	ha	-
E6	Effected area of selected key ecosystems (due to the lignite mining)	ha	-
E12	Loss of arable land	ha	-
E13	Amount of land consumption	ha	-
E14	Area change from greenfield to brownfield	ha	-
*The original indicator is needed to be transformed to negative impact as all the other selected indicators in the set indicate negative impact conditions			

Table 10. Final social indicator set for the local sustainability criteria based assessment

ID	Indicator	Unit	Impact
S6	Number of archaeological sites affecting from the strategy	number	-
S14	Total new land acquisition* (due to the mining operations)	ha	-
S17	Percentage of local population considering the mining sector investment as potentially positive contributor to overcome local problems in terms of infrastructure**	%	-
S18	Percentage of local population think/ observe the mining sector as potential source of conflicts on the local level in terms of environmental issues, including land use and land acquisition	%	-

* Contrary to economic indicator set, land acquisition is seen as a negative impact in the social set in this study because most of the purchased land is agricultural land and it is an important local economic activity of the locals. The applied questionnaire shows that local communities see land acquisition as a negative impact on their society.

** The original indicator is needed to be transformed to negative impact by standardizing the original value as a dominator of 1, as all the other selected indicators indicate negative impact conditions.

Table 11. Final economic indicator set for the local sustainability criteria based assessment

ID	Indicator	Unit	Impact
Ec1	Amount of sellable product production	tonnes	+
Ec8	Produced goods or services per land input	%	+
Ec9	Total cost of land acquisition*	monetary unit	+
Ec10	Recovery of reserve (ratio of alternative's tonne / estimated tonne)	%	+

* The cost of the land acquisition is a negative indicator for the investor but it has a positive impact on land owners from the economic point of view. In this study's case, the cost of land acquisition can be accepted as a positive impact because the public will benefit from the payment and the cost of the acquisition will be covered by the investor(s).

In addition to the listed sustainability indicator sets, the experts are also asked to determine the importance of the environmental, social and economic pillars within a cumulative sustainability score by considering the weak and strong sustainability concepts. The weak sustainability concept is used for a generic sustainability consideration in terms of contributing to the targets of the focused energy policy. Contrary to this, the strong sustainability concept is used to present the locally defined and primarily focusing on the protection of the local traditional economic, social capacities while considering the environmental concerns, mentioned by the locals within the applied survey and focus group meetings. The attributed importance for each pillar is given in Table 12.

Table 12. Imputed importance to the sustainability pillars in terms of strong and weak sustainability concepts

	Environmental Pillar	Social Pillar	Economic Pillar
Weak Sustainability (energy policy focused)	2.0	2.0	1.7
Strong Sustainability (local sustainability criteria focused)	3.0	2.4	1.9

The data collection, needed for analyzing the alternatives with the indicators, is conducted as Step 7. Data, needed for the analysis of the selected indicators are obtained from Düzgün et al. (2015). The reserve model is developed based on 1523 drill logs for obtaining the data on reserve and land use related indicators. Most of the social indicator data is obtained from the 1008 surveys, applied by Düzgün et al. (2015) as well as data is acquired from the Department of Mine Sites under the Electricity Generation Company (EÜAŞ) of MoENR.

For the assessment in Step 8, indicators are aggregated in order to establish environmental, social and economic indices. For aggregating the selected indicators transformation, weighting, valuation, are implemented (Liu, 2014). As quantitative and qualitative indicators with different unit scales are selected by the experts, standardization method is used as the transformation method. The weights of the selected indicators and also each index for calculation of the final sustainability index score (SIS) of each alternative are determined based on the scores, given by the participated experts, with the analytical-hierarchy process (AHP) method.

AHP method is based on determining relative importance values of the indicators, where the relative preference of each pair-wise comparison is represented by these values (Liu, 2014). This process does not give a 'correct answer'; it only provides the best fitting option for a defined problem or issue based on the third parties', i.e. decision-maker, stakeholders, experts. As a result of this, each index gets an index score, which is used to calculate the single sustainability index score (SIS) of each alternative. The equation for calculating SIS of each alternative is given below (Eq.1);

$$SIS= [(- IS_e \times w_e) + (- IS_s \times w_s) + (IS_{ec} \times w_{ec})] \tag{1}$$

Where; SIS is the sustainability index score of the assessed alternative; IS_e, IS_s, IS_{ec} are index scores of environmental, social and economic indicator sets, respectively and w_e, w_s, w_{ec} indicate the weight of environmental, social and economic indicator sets in SIS, respectively. The evaluation of the SISs is conducted by considering the no-action alternative's SIS as the threshold value.

2.1. Implementation of the Proposed Framework for Afşin-Elbistan Coal Basin (AECB)

The proposed framework is applied for Afşin-Elbistan Coal Basin (AECB) in Turkey. The location of the basin is shown in Figure 6. The main reason for applying the framework in AECB is the energy policy of Turkey, which is built on the security of the energy supply. One of the targets to contribute to the policy is to use all of the available domestic primary energy resources, including coal and lignite reserves, for electricity generation. (MoD, 2013; EÜAŞ, 2015, p.13).

In this respect, under the strategic objective of using the available domestic primary energy resources for electricity generation, the AECB becomes the primary focus for the decision-making authority as 38% of the total lignite reserve of Turkey, 4.4 billion tonnes, is located in the AECB (EÜAŞ, 2015). The AECB covers a license area of 34,310 ha, 29,700 ha of which is owned by EÜAŞ, the energy company owned by the state, and the license area is divided into five sub-sectors by EÜAŞ that are shown in Figure 7. Additionally, two thermal power plants are located in the basin with the total installed capacity of 2,795 MW, which equals to 4% of the total installed capacity of the country (EÜAŞ, 2015).

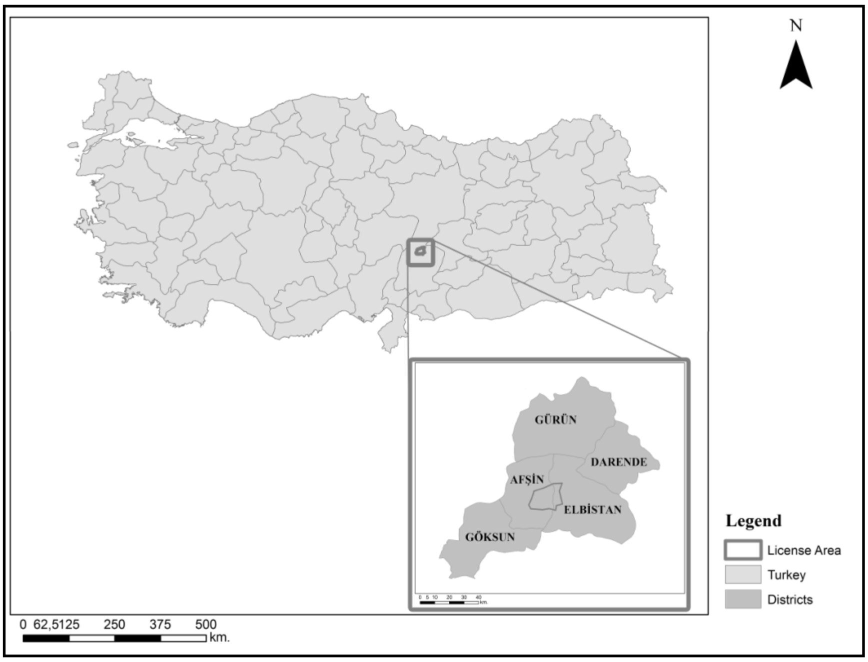

Figure 6. Locations of Afşin-Elbistan Coal Basin in Turkey

The open cast mining operation has been conducted in the AECB in the two sub-sectors, which are Sector A (Kışlaköy Sector) and Sector B (Çöllolar Sector) since 1981 and 2007, respectively. Continuous mining operation is practiced with bucket-wheel excavator and belt conveyor system in Sector A (Yaylacı, 2015). The excavations in Sector B were started with hydraulic excavator and truck systems in order to open the box-cut and after that the mining of the lignite was planned as continuous mining with the BWEs and belt conveyor systems (Tutluoğlu et al., 2011). However, two slope failures occurred in Sector B in 2011. As a result of these, the mining operations were suspended in Sector B in 2011.

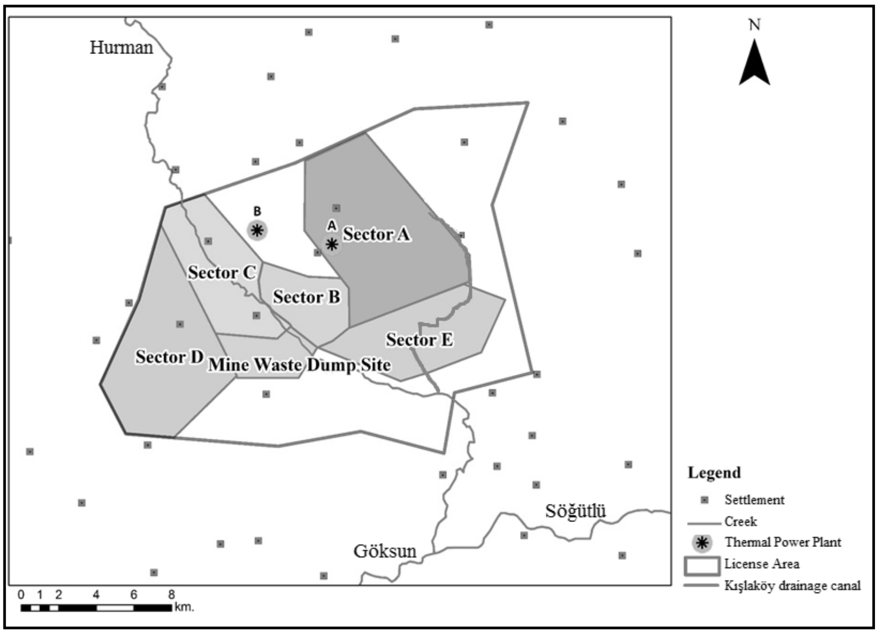

Figure 7. Mining license area in AECB and mining sectors determined by EÜAŞ

The alternatives for the AECB are determined by considering the study-specific objective, scope and the targets. The study-specific objective and targets are determined by the decision-making authority as exploitation of lignite reserves in the AECB by privatization of the C, D and E Sectors (MoD, 2013; EÜAŞ, 2015). The scope, which is mainly land degradation due to the mining sector operations, is defined as a result of determination of the local sustainability criteria. Additionally, the technical parameters, which will potentially affect the possible mining plans in practice, such as distribution of calorific value within the reserve, surface water and geotechnical limitations for practicing the mining operations, are considered during this process. As a result of these, the following alternatives are determined as;

- **Alternative 1:** No-action – continue operations in the Sector A (Kışlaköy) and the Sector B (Çöllolar) (Figure 7)
- **Alternative 2:** Extracting the reserve in Sector D (Figure 7) – No intervention with the Hurman Creek basin, B Power Plant and Sector B
- **Alternative 3:** Extracting the reserve in Sector E (Figure 7)

Elbistan and Afşin are two Districts of Kahramanmaraş Province, locating in the south-east region of Turkey (see Figure 6). The population of the AECB can be counted as the sum of the populations of two districts locating in the basin. Elbistan has 142,168 inhabitants and Afşin has 82,122 inhabitants in 2014 (TURKSTAT, 2015). The basin is the fourth biggest agricultural plain in Turkey. Thus, agriculture and livestock breeding are important traditional local economic activities in the AECB (EMDA, 2014).

3. Results

The results are presented in two sections. The first section, Section 3.1, presents the sustainability assessment results of three alternatives with a specific focus on the energy strategy. Section 3.2 involves the local sustainability criteria based assessment results of three alternatives.

3.1. Energy Policy Focused Assessment Results

The first case focuses on the strategic objective and targets of the energy policy. This is recovering as much lignite reserve as possible while considering the environmental, social and economic factors that are considered through indicator scoring. Additionally, the weights of each pillar, used for calculating the final sustainability score of the alternatives, are asked to be determined based on the explanation of weak sustainability. The obtained results for the energy focused assessment are given in Table 13 and Figure 8. Each alternative is obtained a score for environmental, social and economic indices. As it is given in Table 13, all the alternatives have negative environmental index scores. Accept the no-action alternative; others have also negative social index scores. The economic index scores, on the other hand, are all positive for three alternatives.

Table 13. Sustainability scores based on AHP in the energy focused assessment

	AHP weight	No-action Alternative	Alternative 2	Alternative 3
Environmental Index Score (ISe)		-1.43	-1.94	-3.01
Social Index Score (ISs)		0.45	-1.26	-0.56
Economic Index Score (ISec)		2.81	4.35	2.37
Environmental Pillar	0.40			
Social Pillar	0.40			
Economic Pillar	0.20			
Sustainability Index Score (SIS)		**0.17**	**-0.41**	**-0.95**

Regarding these results, it is not straight forward to decide which alternative should be selected. Therefore, pillar weights are calculated based on the experts scores by using AHP method and the obtained weights are given in Table 13 as 0.4, 0.4 and 0.2 for environmental, social and economic pillars, respectively. As a result of calculating the sustainability index scores (SIS), it is found that only no-action alternative gets a positive score.

Figure 8 presents that the economic index has high positive values. Especially Alternative 2 has the highest economic score, while the environmental index has significant negative values, especially for Alternative 3. However, even Alternative 2 obtains the highest economic index score, cumulative score, SIS, of it is negative due the given importance to environmental and social pillars by the experts.

3.2. Local Sustainability Criteria Focused Assessment Results

The results for the second case, which mainly focuses on integrating the local sustainability criteria into the assessment and evaluation process, are given in Table 14 and Figure 9. For the indicator selection and evaluating the pillar weights, consideration of the possible minimum land disturbance, indicated by the local stakeholders, are stressed. For this purpose, due to the significant interaction of land disturbance and agriculture, strong sustainability concept is considered and the experts performed scoring of indicators and pillar weights, accordingly.

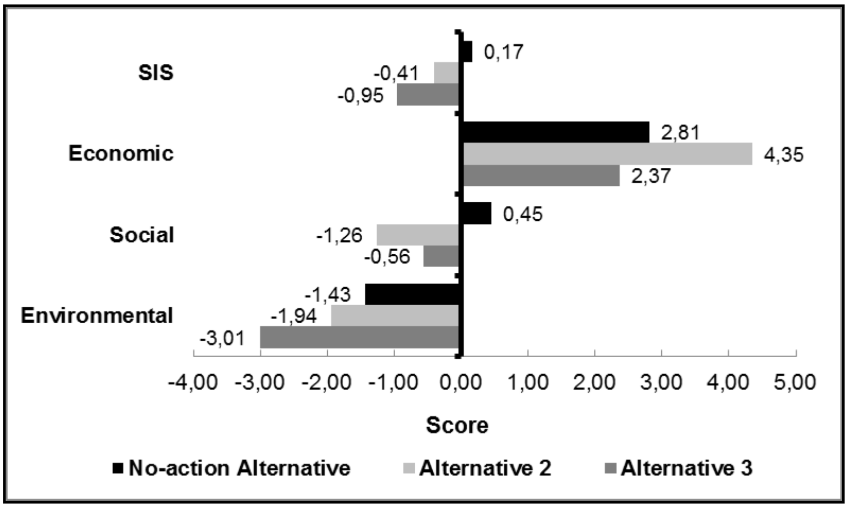

Figure 8. Sustainability scores for the energy focused assessment

As a result, environmental and social index scores are obtained as negative for all the alternatives, (Table 14). Like energy focused case, Alternative 2 has the highest score in the economic pillar, where all three alternatives have positive scores. However, as it can be seen in Figure 9, the environmental index scores of all the alternatives have higher negative values than the economic pillars. Additionally, due to the considerable difference between the weights of environmental and economic pillars, (Table 14), SISs are significantly negative for all the alternatives

Table 14. Sustainability scores based on AHP in the local sustainability focused assessment

	AHP weight	No-action Alternative	Alternative 2	Alternative 3
Environmental Index Score (ISe)		-2.36	-3.08	-3.50
Social Index Score (ISs)		-0.07	-1.50	-0.70
Economic Index Score (ISec)		1.47	2.52	1.70
Environmental Pillar	0,545			
Social Pillar	0,287			
Economic Pillar	0,168			
Sustainability Index Score (SIS)		**-1.06**	**-1.69**	**-1.82**

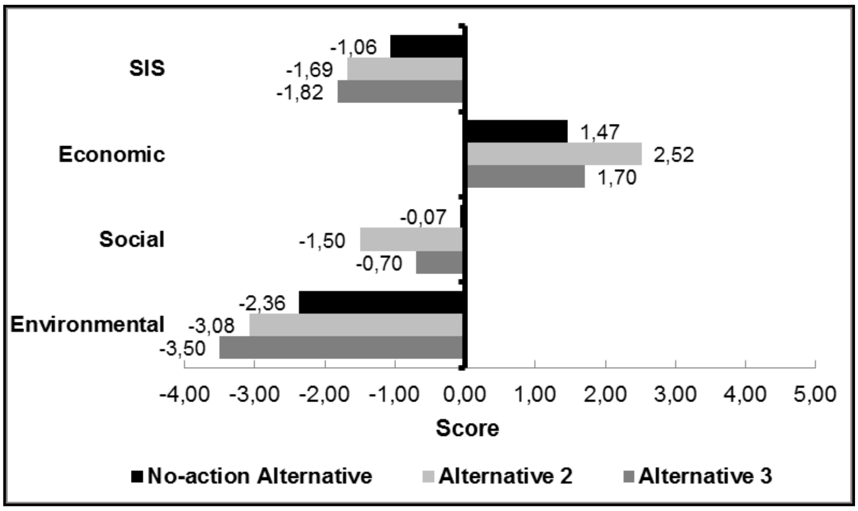

Figure 9. Sustainability scores for the local sustainability focused assessment

4. Discussion

The obtained results for all the cases and the alternatives are compared in Table 15. The scores vary based on the determined pillar importance within the calculation of the cumulative scores for each alternative. Therefore, the scores and their comparison are performed under weak and strong sustainability SISs in Table 15

Table 15. Comparison of SIS values for weak and strong sustainability criteria of three mining plan alternatives in the AECB

ID	No-action (Alternative 1)	A1 & A2	A1 & A3	A1 & A2 &A3
Weak sustainability based SIS	0.17	0.17 vs. -0.41	0.17 vs. -0.95	0.17 vs. -0.41 vs. -0.95
	0.17	**-0,41**	**-0,95**	**-0,95**
Strong sustainability based SIS	-1.06	-1.06 vs. -1.69	-1.06 vs. -1.82	-1.06 vs. -1.69 vs. -1.82
	-1.06	**-1.69**	**-1.82**	**-1.82**

As the main purpose for implementing the framework is to make a recommendation for selecting the sustainable alternative in the AECB based on a systematic and quantifiable approach through considering different parameters; a threshold value is needed for valuation. In this regard, the SIS of no-action alternative is set as the threshold value for further comparison. Also, this is accepted as the lowest level of sustainability in the AECB because if no further mining related action will be taken in the basin, the obtained score indicates the current sustainability condition. This is important as the sustainability of a system is determined by the least sustainable component of it (Mayer, 2008).

Therefore, any alternative with lower SIS indicates degradation in the sustainability level in the AECB. As a result of the comparisons of SISs in Table 15, both in weak and strong sustainability cases, no-action alternative has higher sustainability score than other two alternatives. Hence, no-action should be practiced in the AECB in order to protect the current level of sustainability or other alternatives should be developed and evaluated. In fact, it should be considered that, the obtained results can be changed based on the selected indicators, given pillar weights and modification of possible future alternatives.

5. Conclusions

An indicator-based sustainability assessment framework is proposed and applied with a case study in Turkey for evaluating the sustainability of the current and the proposed lignite mining sector plan alternatives at the strategic level in terms of energy policy and sustainability criteria.

Integration of the local sustainability criteria into the decision-making process is aimed to achieve with a bottom-up approach. The local sustainability criteria in this study indicate the perception, experiences and understanding of the locals about the sustainability in their region with the specific focus on lignite mining practices. Instead of generic definitions, the importance of integration of the local understanding and values on environmental and socio-economic parameters into the assessment and decision-making process systematically at the strategic-level is highly noticed and tried to be practiced within the proposed framework.

The bottom-up approach is practiced through focus group meetings, face to face discussions and survey application in the focused basin. Besides the local stakeholders' contributions, expert consultation is conducted for minimizing the subjectivity while selecting the indicators and assigning the pillar weights. The framework is also applied for top-down approach where energy policies in Turkey are taken into account and experts provided input by scoring the indicators and their weights.

The results of top-down and bottom-up approaches indicate that no action alternative is always better than the proposed alternatives. Therefore, the mining companies as well as the license owner in the AECB need to develop more alternatives (e.g. resetting the recently inactive subsectors, Sector C, D, and E, into a new sectoral outlines, considering the options for management of Hurman Creek, which cross cuts the AECB, and the groundwater conditions in the basin, should be practiced for minimizing the land degradation and maximizing the reserve recovery for effective natural resource management and change the mining practice so that local sustainability can be improved.

In this respect, the proposed framework has advantages to practice the sustainability evaluation and obtain justifiable results faster and likely easier to perform further analysis. Additionally, the framework gives opportunity to practice the assessment based on the availability and accessibility of data that is also an important feature for the strategic-level decision support due to the limited time and expertise capacities of the governmental authorities, at least in Turkey's case.

Determining the stakeholders' sustainability criteria, covering as much practically applicable alternatives as possible, minimizing the data availability limitations, accessing and involving as much stakeholder as possible in an early level of the study are the key factors for a systematic and justifiable sustainability assessment. In this regard, the limitations on considering all practically applicable alternatives and data accessibility must be underlined.

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Evaluating the Evolution of the Heihe River Basin from 2000 to 2010 Using the Ecological Network Analysis

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Abstract

The Heihe River Basin has been through significant transformation and the sustainability of its water network has been significantly altered by mankind as a result of historical agricultural activity and the more recent water infrastructure investments. While there are many studies examining the sustainability of the Heihe River Basin, most studies focus on single issue criteria and do not have a holistic system-level perspective. As sustainability is a system-level trait a system-level analysis is warranted. The objective of this study is to investigate sustainability of the Heihe River Basin through the ecological network analysis (ENA). We established a framework of the ecological network analysis that can be used to examine sustainability of a river basin. We collected detailed data from the flow network, such as precipitation, river discharge, groundwater storage change in the Heihe River Basin from 2000 to 2010. We also estimated evapotranspiration from different land uses based on the heat balance at the surface using the daily mean air temperature, relative humidity, and wind speed. Compared to previous studies (Li et al., 2009; Li and Yang, 2011), our study successfully combined hydrological model into the existing method of the ecological network analysis. The system-level metrics of the basin were measured and through these metrics the evolution of the basin was examined. Specifically through the metrics of efficiency, resilience, redundancy, cycling, and robustness, the long term effects of agricultural development and the more recent effects of water infrastructure investment in the Heihe River Basin. The proposed ENA methodology is significant in terms of ability to examine sustainability from several different key concepts such as efficiency, resilience, redundancy, cycling, and robustness. This method can be incorporated into existing decision-making support system for integrated water resources management in the river basin. We highlight the importance of combining the proposed ENA methodology into a framework of multi-criteria decision analysis, so called MCDA.

Keywords: Ecological Network Analysis, Sustainability, Water Resource Management, Heihe River Basin

An integrative sustainability assessment model for health, safety and environment in Tehran municipalities

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Abstract

Over the last decade, sustainability assessment provides a way for local authorities to measure their performance towards sustainable development and disclose the results of progress to the target population. Despite the fact that the concept of sustainability assessment has grown rapidly in private organizations, it is not apparent that municipalities as public organizations have been taken into consideration for designing a tool to assess their sustainability performance. Furthermore, recently some methods in urban sustainability assessment have been emerged, but a major problem of these methods is the lack of integrated assessment approach to cover significance aspects of municipalities' activities: Health, Safety and Environment (HSE). This paper addresses these new aspects of municipal sustainable development by combining them in an integrated assessment model. The object of this paper is to help municipalities exploring the sustainability level of their HSE performance and providing the ability of comparison between municipalities by presenting a quantitative index. Tehran municipalities is presented as the focal case study. To build the model, Factor Analysis method (FA) was applied to reduce the complexity of HSE indicators by summarizing them to smaller factors. To achieve this goal, research method was divided into 4 main phases i) a review of available municipal HSE assessment tools and indicators: i) developing a survey to identify the importance of each selection indicators, ii) applying Exploratory Factor Analysis (EFA) to determine latent variable (factors) based on interlinking themes of HSE sustainability iii) combining the results of each theme into an integrative assessment model and verifying the proposed model by applying CFA fit indices, and iv) Developing "HSE Sustainability Index (HSESI)" based on the factor loadings. Software tools SPSS 22 and LISREL 8.5 have been used for analysis. The EFA results presented a set of 75 indicators and revealed them to overall 24 factors solutions including 2 health, 7 safety, 4 environmental, 4 Health-Environmental and 7 HSE factors. The results showed that the factors accounted for approximately 70% of the total variance with considerably reduced the complexity of the assessment by using the proposed model with 30% loss of information. The results also showed that all the CFA fit indices were sufficient in terms of model fit. In addition, HSESI was divided into four levels based on the factor loadings: i) poor (score ≤20), ii) moderate (20 <score ≤ 40) iii) good (40< score ≤ 60) iv) excellent (score > 60). The presented index makes it possible for mega-municipalities to compare their state of HSE performance towards sustainability with other counterparties by providing a quantitative rank, as well as encourage them to promote their ranks in compare with others.

Keywords: Sustainability assessment; structural equation modelling; Health; Safety; Environment.

Towards an integrated assessment of social performance relative to planetary boundaries

Andrew L Fanning and Daniel O'neill

Abstract

There is a growing understanding of the biophysical processes that regulate the stability of the Earth-system, yet unsustainable human pressures on the planet continue to increase rapidly. Here, recent advances in translating planetary boundaries down to national and sub-national levels are integrated with social indicators of well-being.

On the biophysical side, a set of 10 indicators is developed that links the sustainability of resource flows from the biosphere to final consumption. The biophysical indicator set includes three measures of physical stocks, three measures of aggregate resource consumption, and four indicators of sustainable scale. The four scale indicators are ratios of (i) cumulative carbon footprint relative to carbon budget, (ii) nutrient use relative to biogeochemical boundaries, (iii) blue water consumption relative to monthly basin-level availability, and (iv) land footprint relative to biocapacity. The set of biophysical indicators measures how close high-consuming societies are to meeting the conditions of a "steady-state economy", defined here as an economy with non-growing physical stocks and flows maintained within shares of planetary boundaries. The biophysical indicator framework is applied over a 15-year period to the economies of Canada and Spain, along with two sub-national regions (Nova Scotia and Andalusia). Nova Scotia is the only study site experiencing stable or decreasing biophysical stocks and flows. None of the study sites are consuming resources within their shares of all four planetary boundaries. Overall, the biophysical indicators provide guidance for prioritizing which environmental pressures need to decline (and by how much) for societies to be more effective stewards of Earth-system stability.

For social performance, a set of 6 indicators measure averages of individual life satisfaction, income, life expectancy, freedom to make life choices, social support and perceptions of corruption. Preliminary results from a panel of ~120 countries over the past decade (2005-2015) find evidence for the "Easterlin paradox" – the observation that life satisfaction does not increase with rising income per capita over the long term – but only for those countries with positive growth rates. For low/negative growth countries, income appears to be positively and significantly correlated with life satisfaction over the long-term (~10 years). Rising incomes don't make people happier but falling incomes make them unhappier. Even more relevant from a sustainability perspective, the same effect on life satisfaction appears to be true for carbon footprint per capita growth rates. These findings are still preliminary but they point to one of the main difficulties faced by decision-makers and sustainable policy planners: how to reduce emissions (or achieve other sustainability goals) without making people unhappy? Implications and opportunities will be discussed.

Keywords: Planetary boundaries, social performance, growth, sustainability, life satisfaction

Water, sanitation, hygiene and the global Goals for Sustainable Development: an opportunity to move from coverage to service level

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Abstract

As the MDGs era concluded with the end of the last year, discussion has turned to how to improve post-2015 monitoring strategies. The inclusion of a dedicated Sustainable Development Goal (SDG) on water, sanitation and hygiene (WaSH) requires a fundamental change in the way we assess the sector. Multi-sectoral and system-wide approaches to monitoring and evaluation are needed. They represent a shift from a reduction in the percentage of the population without access to improved water and sanitation to aiming to ensure safely managed drinking water and sanitation services for all (Targets 1 and 2 of SDG number 6). How will we measure and monitor progress? Which indicator framework will be in place? This paper reviews two monitoring approaches that are increasingly adopted by agencies and NGOs in the WaSH sector. In Africa, the waterpoint mapping has been combined with a household survey to produce WaSH data at decentralised level. In Latin America, the Rural Water Supply and Sanitation Information System (SIASAR) initiative was launched in July 2011 to provide updated and reliable information and facilitate sector decision making. From a post-2015 perspective, we analyse the indicator framework of these two initiatives, the information sources employed to collect data, and the monitoring outcomes. For illustrative purposes, one small town in Mozambique and one rural department in Nicaragua are selected as initial case studies. We conclude that multidimensional monitoring systems are adequate to capture a complete picture of the context in which the WaSH services are delivered. In consequence, they are useful to inform the SDG monitoring architecture. In addition, by directing attention to those areas that require special policy attention, they provide evidences to influence decision-making. One specific challenge however that remains unaddressed, namely the indicator framework to report on the progressive elimination of inequalities in access, suggests the way forward.

Keywords: indicator framework, monitoring systems, sustainable development goals, water, sanitation and hygiene

1. Introduction

Water and sanitation are at the very core of sustainable development. Safe drinking water and basic sanitation together with good hygiene produce evident effects on human health and well-being (Cairncross et al., 2010; Fewtrell et al., 2005). In addition to domestic purposes, water is needed for food, energy and industrial processes. These uses are highly inter-connected and potentially conflicting, and they generate wastewater that may cause environmental pollution if not properly managed. As a result, the equitable provision of water and sanitation for people worldwide has become a top priority on the international agenda. In September 2000, the member states of the United Nations unanimously adopted the International Development Goals as the Millennium Declaration (United Nations General Assembly, 2000), and included one specific target to "halve, by the year 2015, the proportion of people who are unable to reach or to afford safe drinking water". At the 2002 World Summit on Sustainable Development in Johannesburg (United Nations, 2002), the MDG target was reformulated to include a specific focus on sanitation. In 2004, the UN General Assembly declared the period from 2005 to 2015 as the “International Decade for Action: Water for Life”, with the aim of renewing attention in the MDGs. And 2008 was declared the International Year of Sanitation, which helped to put sanitation in the spotlight. In this spirit, the UN General Assembly and the UN Human Rights Council recognized water and sanitation as a human right in 2010 (United Nations General Assembly, 2010a, 2010b). With the end of the MDG period in 2015, and despite the significant progress made (Joint Monitoring Programme, 2015a), a great deal remains to be done, particularly as regards sanitation and hygiene. Today, 663 million people still lack improved drinking water sources, and 2.4 billion have nowhere safe to go to the toilet. Among them, it is estimated that fewer than one billion people (946 million) practise open defecation.

There is no doubt that within the MDG period, monitoring data has played a key role in providing the evidence base for a range of different interventions and actions at different levels, from global to local. For instance, while national-level monitoring has served for national policymaking, planning and financing, global monitoring has been useful to determine whether progress on international agreed goals has been reached. The Joint Monitoring Program (JMP) of UNICEF and the WHO has taken over the role of producing such national, regional and global estimates of population using improved facilities since 1990 (Bartram et al., 2014; Cotton and Bartram, 2008). Particularly in 2000, it received a formal mandate to monitor progress towards the MDG drinking-water and sanitation target, with two single indicators: access to improved sources of drinking-water and access to improved sanitation facilities. Admittedly, the indicators employed during the MDG period have fallen short of measuring progress in some key areas, such as those mentioned under the Human Right to Water and Sanitation (United Nations Human Rights Council, 2011): accessibility, reliability, affordability, sustainability and equality in access, among others. In consequence, a considerable number of people who have been erroneously counted in statistics as “covered / served” do not access to a minimum level of service.

The discussion on the post-2015 development agenda has presented an unprecedented opportunity to take this critical analysis a step further and to provide concrete recommendations for the next development framework. Accordingly, and anticipating the need for a strengthened, comprehensive and more responsive post-2015 monitoring framework, the JMP has facilitated since 2011 international consultations on drinking-water and sanitation goals, targets and corresponding indicators (Joint Monitoring Programme, 2012). In 2015, the Open Working Group (OWG) on Sustainable Development Goals (SDGs) report to the UN General Assembly proposed a framework of 17 SDGs covering a range of drivers across the three dimensions of sustainable development: the economic, social and environmental (United Nations General Assembly, 2014). The OWG proposal includes a dedicated goal on water and sanitation, which comprises six technical targets. Targets 6.1 and 6.2 seek to address the unfinished business and shortcomings of MDG target 7c and call for universal access to drinking water, sanitation and hygiene. Ideally, monitoring systems should consistently report on these internationally agreed targets and their indicators to ensure the comparability of the data during the SDG period.

The aim of this research is to review two monitoring approaches that are increasingly adopted by agencies and NGOs in the WaSH sector. In Africa, the waterpoint mapping has been combined with a household survey to produce WaSH data at decentralised level. In Latin America, the Rural Water Supply and Sanitation Information System (SIASAR) initiative has been implemented in seven countries to provide updated and reliable information and facilitate sector decision making. Taking the post-2015 monitoring and reporting architecture as a reference point, we analyse the indicator framework of these two initiatives, the information sources employed to collect data, and the monitoring outcomes. The remainder of the paper is organised in four main sections. It starts by outlining the proposed indicators for post-2015 monitoring under the SDGs framework. Section 3 describes the methods. This section also documents the case studies and elaborates on the studied monitoring systems. In Section 4, the paper discusses about the suitability and validity of these monitoring systems to assess and inform about the proposed post-2015 monitoring outcomes. The paper ends in Section 5 with a synthesis of conclusions and recommendations.

1.1. Sustainable Development Goal 6: Ensure Availability and Sustainable Management of Water and Sanitation for All

The 2030 Agenda includes a dedicated goal on water and sanitation (SDG 6) that sets out to "ensure availability and sustainable management of water and sanitation for all" (United Nations General Assembly, 2014). SDG 6 expands the MDG focus on drinking water and sanitation to cover the entire water cycle, including the management of water, wastewater and ecosystem resources. With water at the very core of sustainable development, SDG 6 does not only have strong linkages to all of the other SDGs, it also underpins them; meeting SDG 6 would go a long way towards achieving much of the 2030 Agenda (UN Water, 2016).

In terms of monitoring this goal, and with a narrow focus on drinking water, sanitation and hygiene, two different targets (6.1 and 6.2) are proposed. In the process of defining the water-related target, international consultations established consensus on the need to better address normative human rights criteria including accessibility, availability, and quality (Joint Monitoring Programme, 2012, 2011). As a result, Target 6.1 reads "by 2030, achieve universal and equitable access to safe and affordable drinking water for all". The proposed new core indicator of "percentage of population using safely managed drinking water services" comprises four elements: i) a basic drinking water source (MDG "improved" indicator), ii) which is located on premises, iii) available when needed, and iv) compliant with faecal and priority chemical standards (Joint Monitoring Programme, 2015b). As regards sanitation, there was consensus among the international community on the need to go beyond access to a basic facility and address safe management of faecal waste along the sanitation chain. Target 6.2 reads "by 2030, achieve adequate and equitable sanitation and hygiene for all, and end open defecation, paying special attention to the needs of women and girls and those in vulnerable situations", and it will presumably be monitored by a new indicator: "percentage of population using safely managed sanitation services" (Joint Monitoring Programme, 2015b). It comprises three main elements: i) a basic sanitation facility (MDG 'improved' indicator), ii) which is not shared with other households, and iii) where excreta are safely disposed in situ or transported and treated off-site.

It can be observed that both targets and indicators used for monitoring are designed to match the normative interpretation as closely as possible, while recognizing that some elements are not yet possible to measure on a routine basis. Specifically, the following tables illustrate how each element of the proposed targets can be understood from a normative perspective.

Table 16. Definition of SDG Target 6.1, from a normative perspective (Joint Monitoring Programme, 2015b)

Target 6.1 – By 2030, achieve universal and equitable access to safe and affordable drinking water for all	
Keywords, in proposed targets	**Normative interpretation**
universal	Implies all exposures and settings including households, schools, health facilities, workplaces, etc.
and ***equitable***	Implies progressive reduction and elimination of inequalities between population sub-groups
access	Implies sufficient water to meet domestic needs is reliably available close to home
to ***safe***	Safe drinking water is free from pathogens and elevated levels of toxic chemicals at all times
and ***affordable***	Payment for services does not present a barrier to access or prevent people meeting other basic human needs
drinking water	Water used for drinking, cooking, food preparation and personal hygiene

for all	Suitable for use by men, women, girls and boys of all ages including people living with disabilities

Table 17. Definition of SDG Target 6.2, from a normative perspective (Joint Monitoring Programme, 2015b)

Target 6.1 – By 2030, achieve access to adequate and equitable sanitation and hygiene for all and end open defecation, paying special attention to the needs of women and girls and those in vulnerable situations	
Keywords, in proposed targets	**Normative interpretation**
access	Implies facilities close to home that can be easily reached and used when needed
to ***adequate***	Implies a system which hygienically separates excreta from human contact as well as safe reuse/treatment of excreta in situ, or safe transport and treatment off-site
and ***equitable***	Implies progressive reduction and elimination of inequalities between population sub-groups
sanitation	Sanitation is the provision of facilities and services for safe management and disposal of human urine and faeces
and ***hygiene***	Hygiene is the conditions and practices that help maintain health and prevent spread of disease including handwashing, menstrual hygiene management and food hygiene
for all	Suitable for use by men, women, girls and boys of all ages including people living with disabilities
end ***open defecation***	Excreta of adults or children are: deposited (directly or after being covered by a layer of earth) in the bush, a field, a beach, or other open area; discharged directly into a drainage channel, river, sea, or other water body; or are wrapped in temporary material and discarded
paying special attention to the ***needs of women and girls***	Implies reducing the burden of water collection and enabling women and girls to manage sanitation and hygiene needs with dignity. Special attention should be given to the needs of women and girls in 'high use' settings such as schools and workplaces, and 'high risk' settings such as health care facilities and detention centres
and ***those in vulnerable situations***	Implies attention to specific WASH needs found in 'special cases' including refugee camps, detention centres, mass gatherings and pilgrimages

2. Methods

In terms of methods, the study builds on a combination of literature review and specific local experience from the case studies. First, an extensive desk review has been conducted about two main topics: i) the present JMP post-2015 global monitoring proposal: goals, targets and indicators, and ii) key documentation related to frameworks and approaches for WASH monitoring (papers, technical reports and grey literature).

In parallel to the literature review, two different case studies from Africa and Central America have been selected as case studies. In each case study, a specific monitoring framework has been adopted and adapted to the local context. In sub-Saharan Africa, mapping of water points (WPM) has been in use by NGOs and agencies worldwide for over a decade (WaterAid, 2010; Welle, 2010). A major strength of WPM is, per definition, comprehensiveness with respect to the sample of water points audited, which entails complete geographic representation of all strata in the study area (i.e. all enumeration areas as communities, villages, etc.). Taking advantage of this logistic arrangement, and in addition to the mapping, a household-based survey may be conducted to evaluate sanitation and hygienic practices at the dwelling (Giné Garriga et al., 2013). As it may be assumed that all households are located within walking distance of one water source, the approach adopted practically ensures full inclusion of families in the sampling frame. In brief, the data collection method combines a mapping of water sources with a stratified survey of households.

In Latin America, the "Rural Water Supply and Sanitation Information System" (SIASAR) initiative was launched by the Governments of Honduras, Nicaragua, and Panama in partnership with the World Bank in July 2011. SIASAR is currently implemented in four additional countries, namely Dominican Republic, Costa Rica, the Mexican State of Oaxaca, and Peru. This information system aims to monitor and assess sustainability of rural water and sanitation services, by providing updated and reliable information on status and functionality of water supply and sanitation facilities. Its conceptual model covers a broad range of aspects, which are combined in four basic dimensions:

- Access to service, as determined by coverage information gathered at the community level;
- Quality of service, as determined by the level of service, functionality and physical condition of the infrastructure serving a community;
- Performance of service providers, as determined by the level of organization, O&M attention and financial sustainability of the local service provider; and
- Effectiveness of technical assistance, as determined by effective support of technical assistance providers (municipal employees) to run WSS systems.

It can be easily observed from previous paragraphs that there are similarities and differences among the two monitoring systems, although they share a common rationale, i.e. to provide a complete picture of the context in which water and sanitation service are delivered. Table 3 underlines key aspects of both approaches.

Table 18. Differences and similarities among two monitoring approaches for WaSH

Water Point Mapping + Household Survey	SIASAR
- Focus on local estimates - Adequate methodology when water is largely supplied through community water points, either connected to a water system or not (e.g. rural Africa) - Combination of two information sources, i.e. the household and the waterpoint. A census of schools and health centres could be also conducted in case of need - Combination of different techniques: structured questionnaire, direct observation, and water quality testing - Involvement and participation of local authorities and community leaders	- Focus on national and subnational / local estimates - Adequate methodology when water is largely supplied through decentralised water systems (e.g. Latin America) - Combination of different information sources, i.e. the system, the community, the service provider and the technical assistance provider - Combination of different techniques: structured questionnaire, direct observation, and water quality testing - Involvement and participation of local authorities and community leaders in data collection - Involvement of national authorities and key stakeholders in the definition of the indicator framework

2.1. Indicator framework A: combining waterpoint data and household data to monitor rural

WaSH

In the first case, the approach adopted for data collection combines a mapping of water sources with a stratified survey of households. Different methodologies exist which combine the waterpoint and the household as key information sources, but they commonly differ from the method proposed herein in i) the focus - national rather than local -, and in ii) the statistical precision of the estimates - inadequate to support local level decision-making -. In brief, the key features of the proposed method include i) an exhaustive identification of enumeration areas (administrative subunits as communities, villages, etc.); ii) audit in each enumeration area of all improved and unimproved water points accessed for domestic purposes; and iii) random selection of a sample size of households that is representative at the local administrative level (e.g. district, municipality, etc.) and below (Giné Garriga et al., 2013).

Despite the large amount of collected data through survey instruments designed for the waterpoint and the household, rigorous data analysis and dissemination is crucial to inform decision-making. Information about institutional, financial, management and environmental issues should be included in the indicator framework, but exhaustiveness needs to be balanced with simplicity. For this purpose, a reduced set of indices are defined on the basis of simple planning criteria (Giné Garriga et al., 2015). For each index, one ranking is produced and transposed into one league table to denote priorities. A different threshold limit is set per list for this purpose. To show at a glance both index values and priorities, different maps are developed, which enable a quick identification of key focus areas. Finally, each priority list is related with specific remedial actions to be accomplished by the local government, ultimately translating development challenges into beneficial development activities. A proposed list of indices is summarized in Table 4 (Giné Garriga et al., 2015).

This data collection methodology has been applied in various settings in East Africa (Giné Garriga and Pérez Foguet, 2013; Giné Garriga et al., 2015). The Municipality of Manhiça has been selected for illustrative purposes. It is located in Manhiça District, Maputo Province, in southern Mozambique. It has 19 bairros and covers a rough area of 250 km2. According to the local estimates, the population roughly totals 61,000 distributed in peri-urban and rural contexts.

The following pictures and Table 5 show the outcomes of this monitoring approach. It can be observed that by disseminating the planning indices listed in Table 4 through league tables and priority maps improves transparency and inclusiveness in the decision-making process. They are powerful tools to produce simple policy messages that are easily understood by decision-makers, non-technical stakeholders and the recipient populations. For instance, the “open defecation index” is useful to show those bairros in Manhiça where this practice is common. In total, 14.2% defecates in the open, although disparities exist by bairros. It can be seen that a large majority of households defecate in the open in Ribjene (61.3%), while in other bairros this practice has been almost eliminated. In those bairros where open defecation is widespread, the coordination of initiatives to support new construction of facilities, or the launch of total sanitation campaigns, such as those focused on the Community Led Total Sanitation (CLTS) approach (Kar and Chambers, 2008), would emerge as potential remedial actions. They all would trigger a movement on the sanitation ladder.

Table 19. Indices used for planning (Giné Garriga et al., 2015)

Index	Definition	Remedial Action
INDICES RELATED TO WATER SERVICE COVERAGE		
Coverage index	% of covered population by improved waterpoints (IWP) in a location, according to the standards of service level (e.g. 1 waterpoint / 250 people)	Construction of New waterpoints
INDICES RELATED TO THE MANAGEMENT OF THE SERVICE		

Functionality Index	% of functional improved waterpoints (FIWP), compared to the total number of IWP	Rehabilitation of existing waterpoints
Management Index	% of FIWP with declared income and expenditure in the year before the survey	Management supporting activities, particularly those related to creation / establishment of water entities or to financial issues (tariff collection systems)
Maintenance Index	% of FIWP with good / acceptable access to technical skills and spare parts	Management supporting activities, particularly those related to technical issues. Improve spare parts accessibility
INDICES RELATED TO THE QUALITY OF THE SERVICE		
Seasonality Index	% of FIWP that are year-round	Actions to increase reliability of the source (catchment's protection, regulation of different uses) and/or finding of additional sources
Water Quality Index	%of FIWP with acceptable bacteriological quality	Actions to improve quality of water: catchment's protection, protection of WP, water treatment, etc.
INDICES RELATED TO SANITATION SERVICE		
Coverage Index	% of covered households by improved sanitation facilities (ISF)	Construction of new facilities
Open Defecation Index	% of households that practice open defecation (OD)	Community-led Total Sanitation
INDICES RELATED TO HYGIENE		
Latrine Sanitary Conditions Index	% of latrines that are maintained in adequate sanitary conditions. Risky conditions might prevent an adequate use	Hygiene promotion campaigns
Handwashing index	% of adults with appropriate handwashing (HW) knowledge	Hygiene promotion campaigns, particularly focused on handwashing

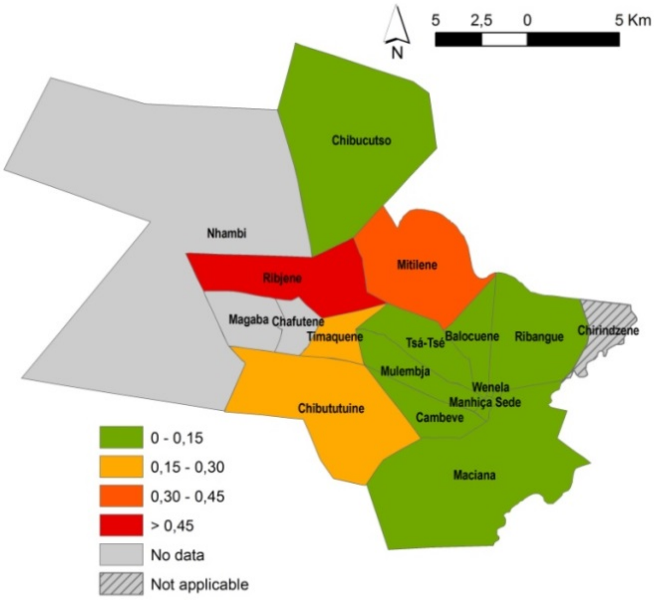

Figure 10. Open Defecation Index

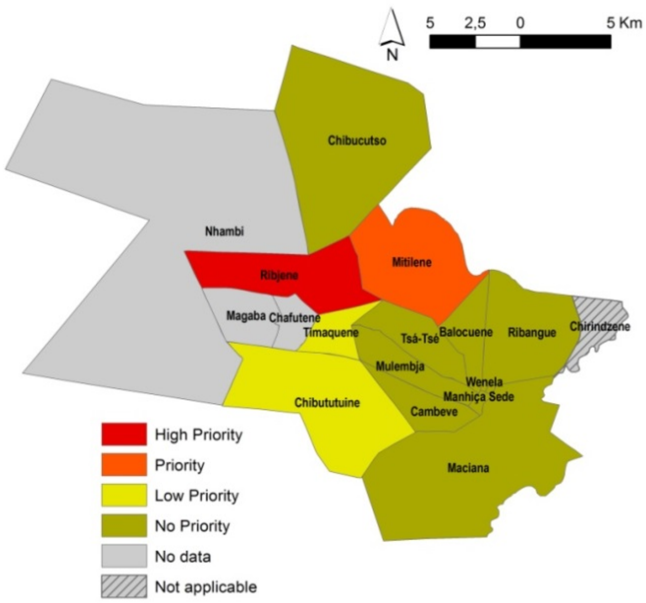

Figure 11. Open Defecation – Priorities

Table 20. Categorization of bairros from Manhiça in relation to the practice of open defecation

Bairro	Rank	p_i	$p_{l,i}$	$p_{u,i}$	Prioritization
Matadouro	13	0,000	0,000	0,048	Lowest Priority
Ribangue	14	0,000	0,000	0,046	Lowest Priority
Maciana (includes Maragra)	12	0,007	0,000	0,037	Lowest Priority
Manhiça Sede	10	0,013	0,000	0,072	Lowest Priority
Wenela	11	0,013	0,000	0,072	Lowest Priority

Cambeve	9	0,026	0,003	0,091	Lowest Priority
Tsá-Tsé	8	0,038	0,008	0,108	Lowest Priority
Balocuene	7	0,051	0,014	0,126	Lowest Priority
Chibucutso	5	0,067	0,022	0,149	Lowest Priority
Mulembja	6	0,067	0,022	0,149	Lowest Priority
Timaquene	4	0,229	0,137	0,344	Low Priority
Chibututuine	3	0,244	0,153	0,354	Low Priority
Mitilene	2	0,347	0,240	0,465	Priority
Ribjene	1	0,613	0,494	0,724	High Priority
Notes: a) α = 0.05 (95% confidence); b) Three bairros are excluded from the analysis since the sample of HHs is not adequate to achieve required statistical precision					

Table 21. Structure of SIASAR: indices and components

Water Service Level (WSL)	Water System Infrastructure (WSI)
Accessibility Continuity Seasonality Quality	System autonomy Infrastructure for water production Water caption protection Water Treatment system
Community Sanitation and Hygiene (CSH)	**Service Provider (SEP)**
Sanitation service level Personal hygiene Household hygiene Community hygiene	Organizational capacity Operation & Maintenance Financial management Environmental management
Schools and Health Centres (SHC)	**Technical Assistance Provider (TAP)**
Water supply in schools Sanitation in schools Water supply in health centres Sanitation in health centres	Information & Monitoring system Institutional capacity Coverage (number of communities attended) Intensity (typology of assistance)

2.2. Indicator framework B: the "Rural Water Supply and Sanitation Information System" (SIASAR)

In the second case, the monitoring system includes a comprehensive set of indicators assessed through four different survey instruments: i) the community, ii) the water system, iii) the service provider, and iv) the technical assistance provider. In brief, the indicator framework is based on three fundamental pillars: i) data collection and data update procedures, ii) definition of aggregated indices for partial and overall performance monitoring; and iii) definition of planning indicators. Remarkably, a cross-cutting issue within all these processes is the active engagement of national stakeholders, which in turn promotes greater ownership of the system by final users.

One of the salient aspects of SIASAR is the definition of six aggregated indices to assess water and sanitation services from different and complementary points of view. They have been proposed to measure i) the water service level; ii) the community sanitation situation and various hygiene issues at the household; iii) the condition of water system infrastructure; iv) the service provider performance; v) the technical assistance provider performance; and vi) the WaSH situation in public institutions. These indices are listed in Table 6. Each index is made up of four components. In turn, each component is fed by a short list of single indicators. Typically, data are represented on different scales (e.g., percentage of systems with adequate water treatment, distance-to-source in meters, service continuity in hours per day, and so forth), and they therefore have to be normalized prior to their analyses. For each parameter, we assigned a score between 0 and 1, where 1 represents the best performance and 0 the worst case scenario. Components are then defined by simple and easy-to-use multi-attribute utility functions. As regards the index construction, the method involves three key stages: i) determination of weights for each component, ii) their aggregation to yield a single value; and iii) presentation and dissemination. For simplification and to promote greater understanding of achieved results among final users and stakeholders, equal weights and an additive aggregation form has been opted for. Similarly, indices' values are linked to a defined set of categories (A / B / C / D), in order to foster prioritization and decision-making.

SIASAR is today in use in seven countries, namely Honduras, Nicaragua, Panama, Dominican Republic, Costa Rica, the Mexican State of Oaxaca, and Peru. To illustrate, one Nicaraguan department has been selected as case study. Matagalpa is located in central Nicaragua. It covers an area of 8,523 km2, and according to official data the population is estimated at 542.419. The capital is the Municipality of Matagalpa; and administratively, the department is divided into 13 municipalities. Maps in Figures 3 and 4 give a visual representation of two components of two different indices as potential monitoring outcomes of the system. To interpret the results, indices' values can be easily understood through two limit examples. Let us consider the case of a community with a partial index equal to 0.5.This may have two different meanings: i) two components obtain optimal results (i.e. utility function equal 1) and the rest of components obtain the lowest score (i.e. utility function equal 0), or ii) the four components obtain a score of 0.5. There is a direct trade-off between components of the partial indices, due to the additive aggregation (Munda and Nardo, 2005). Similar interpretation applies at other scales, when a number of communities are grouped together in higher administrative units. In this case, however, there are two additional limit scenarios: i) all communities score the same value, or ii) half obtain optimal results and the other half score 0. There is also a direct trade-off among communities

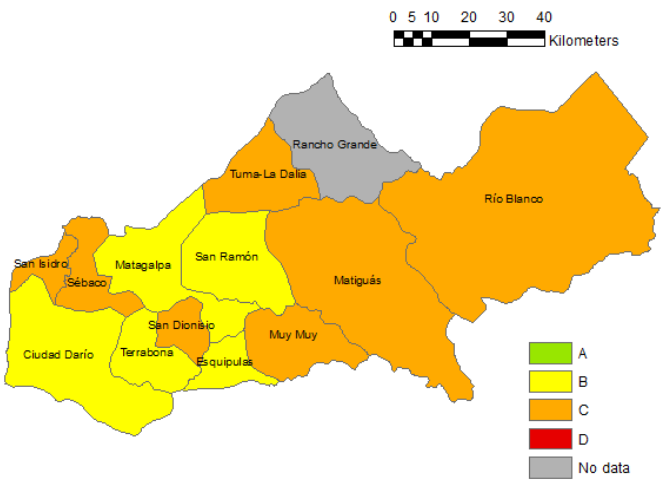

Figure 12. Sanitation service level

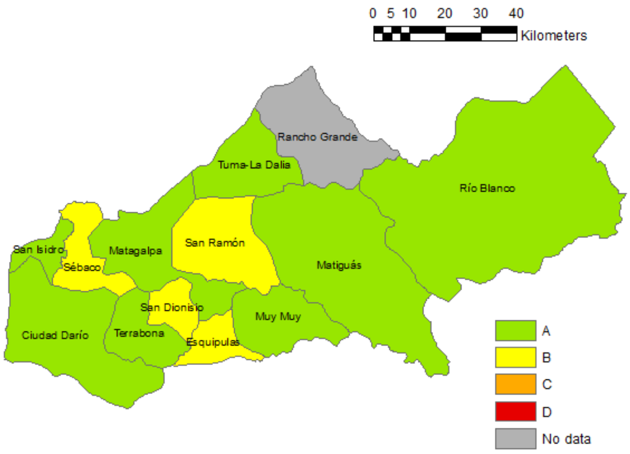

Figure 13. Infrastructure for water production

3. Results and Discussion

In this section, we review the previously described monitoring approaches and analyse their validity to inform the post-2015 targets and indicators that have been proposed for the WaSH sector. To do this, available indicators in both systems are classified in relation to the key elements identified in each target. Tables 7 and 8 summarize the list of indicators per each target element.

Table 22. Summary list of indicators to assess the water-related Target 6.1

Keywords, in proposed targets	Indicators - WPM + HH Survey	Indicators - SIASAR
universal	*** to assess this element, the method needs to include a census of schools and health centres	▪ % of households with improved water supply ▪ % of schools with improved water supply ▪ % of health centres with improved water supply
and ***equitable***	▪ % households with access to improved water supply. Population is stratified in wealth quintiles.	▪ No data (no focus on vulnerable groups). Basic ethnicity data are collected, although analysing them in relation to WaSH issues is not straightforward.
access	▪ Average rate of per capita domestic water consumption ▪ % of households spending, on average, more than 30 minutes in fetching water ▪ % of non-seasonal waterpoints	▪ Time to fetch water (assessed at community level, in terms of distance to the source) ▪ Service continuity (number of hour per days) ▪ % of non-seasonal water sources

to ***safe***	- % water sources with no bacteriological contamination - % households with adequate point-of-use water treatment	- % of water systems with adequate treatment method - % of households with adequate treatment method - Bacteriological water quality - Physicochemical water quality
and ***affordable***	- % water entities which exempt vulnerable houses from paying for water - % households that have been excluded from the service, because of a failure to pay	- No data Comment: SIASAR collects data on water tariffs and the water payment method. Also, on the number of users that regularly pay the water bill. This information may be exploited, in part, to give an insight into affordability issues
drinking water	- Domestic water uses (drinking, cooking, food preparation and personal hygiene)	- No data
for all	- Safety and security while accessing the waterpoint - % of waterpoints with user-friendly design	- No data

Table 23. Summary list of indicators to assess the sanitation-related Target 6.2

Keywords, in proposed targets	Indicators - WPM + HH Survey	Indicators - SIASAR
access	- Toilet facility location - Continuity of use of the latrine	- No data
to ***adequate***	- Safe management and disposal of human urine and faeces	- % households sharing improved sanitation facilities (assessed at community level) Comment: No data is available in relation to treatment of excreta in situ, or safe transport and treatment off-site
and ***equitable***	- % households with access to improved sanitation. Population is stratified in wealth quintiles.	- No data (no focus on vulnerable groups). The questionnaire, however, measures to a certain extent intra-household inequalities

sanitation	- % households with access to improved sanitation - % households sharing improved sanitation facilities (assessed at community level) - Sanitary conditions of the latrine (presence of insects, unpleasant smell, and cleanliness)	- % households with access to improved sanitation (assessed at community level) - % households sharing improved sanitation facilities (assessed at community level)
and ***hygiene***	- Hand washing facility and soap in the vicinity of the latrine - Hygienic practices in the latrine (materials for and anal and genital cleansing, menstrual hygiene management, hygienic disposal of cleansing materials and menstrual products	- % households with adequate handwashing behaviour (assessed at community level)
for all	- Safety and security while accessing the sanitation facility - Safety and security while using the sanitation facility - Latrine standards (condition of lined pit and upper superstructure) - Conditions of privacy in the latrine - Conditions of comfort in the latrine	- % of households where sanitation facilities are used by all household members
end ***open defecation***	- % households practicing open defecation	- % households practicing open defecation (assessed at community level) - % of Open Defecation-Free (ODF) community
paying special attention to the ***needs of women and girls***	- % households in which women shoulder the burden in collecting water - Hygienic practices in the latrine (materials for and anal and genital cleansing, menstrual hygiene management, hygienic disposal of cleansing materials and menstrual products	- % schools with access to improved sanitation (assessed at community level) - % health centres with access to improved sanitation (assessed at community level) Comment: SIASAR disaggregates the sanitation data by gender in schools and health facilities
and ***those in vulnerable situations***	- Not applicable	- No data (no focus on specific WASH needs found in 'special cases' including refugee camps, detention centres, mass gatherings and pilgrimages)

It can reasonably be inferred from the previous tables that collecting data at the household brings operational advantages in terms of monitoring post-2015 indicators for drinking water, sanitation and hygiene. This being the case, information systems such as SIASAR - with a focus on the linkages between the sustainability of the water service and the service provider - may also produce valuable and complementary information. Specifically, SIASAR is adequate to report on the proposed drinking-water target. In contrast, as regards the sanitation and hygiene indicators, important attributes will not be assessed. On the one hand, no information will be available on excreta and/or wastewater treatment, which impedes the adequate evaluation of sanitation services management. On the other hand, accessibility issues are not correctly addressed. Remarkably, both monitoring systems will hardly report on the progressive elimination of inequalities in access to different levels of drinking water, sanitation and hygiene services, as they do not specifically address the needs of vulnerable groups.

4. Conclusions

In embarking upon the 2030 Agenda for Sustainable Development with a dedicated goal on water and sanitation, achieving higher levels of service in WaSH will be a major challenge. A related challenge will be holistic monitoring of these services, and credible data will be needed to stimulate political commitment, inform decision making, underpin sector advocacy and trigger well-placed investments towards improved health and a cleaner environment.

At present, there are several global initiatives that are monitoring different aspects of the water sector, but a coherent framework is still missing. Household surveys and censuses can fill gaps and provide basic information about access to and use of infrastructure, as well as hygiene practices at the household level. These surveys and censuses have provided the great majority of data used for tracking the WaSH MDGs, and will continue to be at the heart of SDG reporting. In rural contexts where water is delivered through decentralised water points, this study advocates for combining household data with infrastructure data. Such combination provides a more complete picture of the context in which the services are delivered. Remarkably, this approach is adequate to measure the different elements included in the water and sanitation SDG targets.

However, as sector capacities strengthen, national Management Information Systems (MIS) can increasingly produce reliable information about the level and quality of the services delivered. Such systems can provide information about management, operation and maintenance of services which can hardly be measured through household surveys or infrastructure assessments. Ideally, service providers should be increasingly involved in monitoring activities, and conduct regular surveillance of drinking water and sanitation services. Such national MIS are still relatively rare and weak in many countries, but SIASAR is a representative example. As it will be uniquely positioned to regularly report on Targets 6.1 and 6.2, SIASAR and other similar monitoring frameworks should be strengthened throughout the SDG period. To this end, it is essential to tailor these systems and their information modules to post-2015 key monitoring elements.

Finally, there is little doubt that inequality has been the biggest blind spot in the MDGs. A key challenge in the SDG period will be on reporting the progressive elimination of inequalities in access to different levels of drinking water, sanitation and hygiene services. The pledge that 'no one will be left behind' requires a specific focus on the poorest and most vulnerable people. For this to happen, transparent mechanisms to target the neediest and their needs should be in place. Today, few monitoring systems incorporate monitoring elements to address the issues of equality and non-discrimination.

In sum, this paper identifies a number of priorities that need to be addressed to develop an effective indicator framework for the SDG 6. They include filling gaps in available indicators; harnessing new, innovative sources of data; adapting information systems in current use, and defining adequate monitoring routines. Indeed, these challenges are of a general nature and not specific to the WaSH sector. On the one hand, emerging consensus suggests that the focus of SDG monitoring will be at the national level. On the other hand, complementary monitoring will occur within major thematic communities, such as health, education, agriculture, WaSH and so forth. Each of these communities will mobilize, analyse, and communicate data on progress towards achieving its specific goals. There is, therefore, a strong need to integrate such thematic monitoring and review within the SDG monitoring architecture, as it will be an important complement to official monitoring and review conducted at national and global levels (Sustainable Development Solutions Network, 2015).

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Developing sustainability indicators to evaluate health, safety and environmental performance in megacities: a study of Tehran municipalities

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Abstract

The adoption of sustainability strategies and practices in local public organizations is an increasing topic of research and discussion. Many efforts have been made to develop sustainability tools that aim to evaluate, monitor and compare the integration of sustainable development polices, plans and practices at this organizational level. Despite the diversity of methods, approaches and case study initiatives to evaluate organizational sustainability performance, the majority focuses on performance indicators applied to the business sector. Sustainability assessment of public sector organizations, including municipalities, is still an underexplored issue, with a lack of research on the integration role of health, safety and environmental (HSE) issues in the existent sustainability performance indicators set. Additionally, there is a particular gap related with the study of megacities and corresponding organization in “mega-municipalities”. There are a large number of activities in mega-municipalities that are directly related to HSE issues, and it is widely demonstrated that municipalities’ authorities cannot evaluate the organizational sustainability without developing a tool to follow-up the state of their organizational HSE performance. The main aim of this research is to develop a performance evaluation tool, supported by indicators, to monitor HSE aspects of sustainable development in mega-municipalities. To put the proposed tool into practice, a set of performance evaluation indicators is proposed for adoption in Iranian municipalities, integrated in the megacity of Tehran, as a case study. In order to support the indicators selection stage, an initial review on HSE indicators was conducted and data was adopted by Delphi technique. Therefore, 2-round questionnaire was carried out involving 12 qualified experts divided in two subgroups: academics and practitioners of Tehran municipalities. The questionnaire was designed to select the most robust indicators of HSE performance and evaluate the priority of each indicator. A total of 91 Indicators were generated and grouped into 30 criteria, 13 categories and 7 themes; Health (H), Safety (S), Environment (E), Health-Safety (HS), Health-Environment (HE), Safety-Environment (SE), and Health, Safety and Environment (HSE). The findings showed that regards to the average scores of 13 categories, “Fire and emergency response” was determined as the most important category, which closely followed by “Transportation” and “Natural systems” categories. Also the findings showed that with respect to the 7 proposed themes, the “HSE theme” performed the most significant roles in enhancing the HSE performance of sustainability in Tehran municipalities, which nearly followed by “safety theme”. It is concluded that in mega-municipalities, social aspects of sustainability gain more attention in compare with environmental ones. Also it is concluded that in mega-municipalities, the indicators related to health and safety could be consider as a ‘key indicators’ and should be stratified in an independent categories to highlight the role of them in municipal sustainable development. Therefore, future efforts should concentrate on enhancing the awareness of all municipalities’ authorities in HSE interlinking indicators to establish local sustainable development strategies in line with their HSE performance strategies.

Keywords: Sustainability; Performance evaluation; Indicators; Health; Safety; Environment.

Proposal of a sustainable development indicator dashboard structured by ends and means

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Abstract

Adoption of Sustainable Development Goals (SDGs) by United Nations General Assembly in September 2015 has drawn attention again to indicators measuring the progresses in activities towards sustainable development (SD). Inter-Agency and Expert Group on SDG indicators (IAEG-SDGs) are now examining what indicators should be selected and SDGs indicators are to be adopted by United Nations in 2016. However, indicators for 169 targets under 17 SDGs are too many and interpretation of the progress is not an easy task. At the same time, a nexus approach, which integrates management and governance across sectors and scales (Hoff 2011), has been paid attention to recently. The approach requires better understandings of complex phenomena of human-environment systems in a structured way. Therefore, we devised a new, structured framework for a sustainable development indicator dashboard to be utilized by national governments which intend to capture the state of development of a country. The framework devised consists of the ends and means as well as the four compass. The four compass were suggested by Atkinson and Hatcher (2001) and consists of four domains: the triple bottom lines (environment, economy, and society) and well-being of individual human beings. The ends and means are conceptually based on the Daly triangle (Meadows 1998), in which ultimate ends are supported and achieved by the use of capitals, as well as a framework of local SD indicators by Kurishima et al. (2015). The framework thus emphasizes not only achievements of well-beings of environment, economy, society, and individuals but also maintaining capitals. Types of capitals are based on the Ekins' four capitals (Ekins et al. 2008): natural, manufactured (as economic), social, and human (as individuals). Indicators under the framework monitor the state of each of the four ends and four capitals. The framework also pays attention to linkages between ends and capitals. To do so, indicators for the linkages monitor efficient use of capitals for the ends and fair distribution of the achieved ends, which enable us to understand phenomena in a more structured way. Based on this indicator framework devised, we collected statistical data of Japan, which covered relatively long periods and discussed the state of the development of Japan. Subsequently, we discussed two models of Japan's development. One model puts a priority on economic development and expects the trickle down to the other achievement of well-beings through increased capitals. The other model focuses on diverse ends and attempts to utilize the current capitals.

Keywords: Indicator, Sustainable Development Goals (SDGs), Nexus, Capital approach, Monitoring

Impacts of hydropower plants in the development of their affected municipalities

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Abstract

Hydropower plants are enterprises which cause negative and positive environmental impacts of different orders during the stages of implementation and operation. In this sense, the environmental aspects of a hydropower plant may be considered as exogenous interferences which interact with the structure and functioning of the local socio-ecological systems. This interaction can determine some reorientation of the local development phenomenon in progress. In Brazil, the federal government has used the justify that hydropower plants improve the local development context, although there are no clear empirical evidences that ensure this association on a national scale. In this context, this paper aims to analyze the development of municipalities performances (local scale) directly affected by Brazilian hydropower plants in order to identify the occurrence of prosperity or enclave scenarios in the municipal development. In order to achieve this, it were identified 600 directly affected municipalities (DAM) for 170 hydropower plants with an installed capacity over than 30 MW, and 1081 municipalities indirectly affected by these same hydropower plant (control). Values of 256 human development indicators for each municipality were obtained, which were produced by Brazilian statistical agency and organized by the Human Development Atlas produced by the United Nations Development Programme (UNEP). For each hydropower plant, the DAM municipalities and control formed two distinct groups that were statistically compared by the values of the 256 indicators in order to identify if these groups belong to the same sampling universe (no difference) or belong to different universes (different). In the latter case, when the groups were different of a given indicator, it was still necessary to identify which group had the highest values. In case of the DAM municipality had the highest values for a given indicator, it can be concluded that there was an association between the presence of the hydropower plant and best performance development in its affected municipalities. In general, results show a deterioration trend of the human development indicator's performance of municipalities flooded opposite neighboring municipalities flooded during the installation of hydropower plants. However, this trend was not observed in the operation period of hydropower plant, which could be the result of a retrieval in the development performance of municipalities after the installation period. Regarding this, we must emphasize that, during operation, the municipalities that have part of their political and administrative territory flooded by the reservoir of a hydropower plant receive financial compensation in order to induce positive effects or to offset the negative effects in local development. However, correlation analyzes were performed to check if there were variations in the human development indicators values versus the compensation values for these municipalities. No statistically significant correlation was observed, which strongly suggests that the financial compensation is not acting in order to enhance the development of the flooded municipalities.

Keywords: development, hydropower plant, human development índex, Impact assessment

Development of non-material sustainability indicators through a community based-approach: the brazilian case of Maceió and Alagoas

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Abstract

Despite the diversity of tools to evaluate regional and local sustainability, indicators sets are one of the approaches most used, also to analyse the interactions between regional and local scales of assessment. Many of the development and applications of Sustainable Development (SD) Indicators follow the guidelines of the Bellagio Principles, where the assessment should reflect a holistic view of the linkage between social, environmental and economic considerations and it should have the appropriate scope while still offering a practical application. Sustainability indicators usually cover the three typical dimensions of SD and several specific thematic areas. However, further than include traditional policy and management issues, indicator initiatives should be also ready to integrate and well reflect the uncertainty values of non-traditional aspects of sustainability, particularly those involving ethics, culture, aesthetics, and general "non-material" values including principles, creeds, traditions, life styles, attitudes and behaviour of individuals and social groups. As far as 1996, the World Commission on Culture and Development stated that it was imperative to identify a core of common ethical values and principles that should guide the complex and ambitious way to development. Other authors emphasized the importance of the cultural dimension of development, as well as the need of a new ethical posture and values. Knowing that real changes will only happen in a society bearing principles and values supporting sustainability, "non-material" sustainability indicators could play a fundamental role. However, there is a significant lack of research about the contribution and weight of this "non-material" dimension of sustainability in the most common indicator systems at national, regional and local levels, where this component is often neglected or underrepresented. The main aim of this paper is the development of non-material sustainability indicators through a community based-approach, and integrates them into a conceptual framework for sustainability assessment and reporting at regional and local scales. A Brazilian regional-local case study is used to explore and test the proposed approach – the state of Alagoas and Maceió municipality. According to a community and participatory based-approach four focus groups were organized: state and local Government, Non-Governmental organizations and private sector stakeholders, to state their perceptions and knowledge about the non-material values and indicators for the case study. A convenient sampling was used for the selection of the stakeholders in each focus group. The focus groups were developed in three phases: i) self-assessment of the state of a formal preliminary list of non-material sustainability indicators developed previously by the researchers team, based on interviews with local stakeholders; ii) stakeholders assessment (in terms of relevance, understanding and feasibility) of the preliminary list of non-material sustainability indicators; iii) assessment by the stakeholders of a puzzle of sustainability dimensions and the possible links with the non-material values. After analysing the results of the four focus-groups, a specific final sub-set of non-material indicators integrated into a conceptual framework is proposed for the sustainability indicators set of Alagoas and Maceió and tested on this municipality and state.

Keywords: EDS – sustainability; non-material indicators; participatory approach; conceptual framework.

Track 1c. Role of Academia

Session 1c-02

Session 1c-03

Session 1c-06

Session 1c-07

Can MOOCs empower people to critically think on climate change?

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Abstract

Climate change can be regarded as one of the overarching topics of sustainable development as the dramatic impacts of climate change will affect societies at all levels. 2015 was a big year for international climate change politics. In November 2015, the 21st Conference of the Parties (COP) in Paris took place where 195 states aimed to negotiate a legally binding agreement to combat climate change. Since the COP is supposed to send out a strong political signal to other actors and arenas, its progress is closely observed by the media and civil society. However, triggering individual action towards climate protection requires informed citizens on the ground. A crucial role for academia in this context is to empower people to be able to understand and critically assess climate change politics. Education is one key area of the recently adopted UN sustainable development goals for

2030. Goal 4 emphasises the importance to promote of lifelong learning opportunities for all. Massive Online Open Courses (MOOC) have started to be used as an education tool to raise awareness and build shared knowledge in different scientific fields. To reach and educate a wide range of people interested in the topic climate change, two MOOC were set up in the run up to the COP21 in Paris, by two distance learning Universities in Europe: The Portuguese and German National Universities (Universidade Aberta and FernUniversität). The English-speaking MOOC "Climate Change – a question of justice" from Fern aimed to provide participants with the competencies to understand the political spin behind the ostensible informal answers commonly uttered by the international community. One of the main stumbling blocks is the different view on climate justice in northern and southern countries. The MOOC "Climate change: the context of lived experiences" from

Aberta aimed to provide participants with the basic knowledge on the topic of climate change, from the science point of view to politics and economics, and also from the social sciences point of view, regarding the importance of the lived experiences of climate change and climate change mitigation or control. Both MOOCs shared their objective to impart to the participant the instrumental competences to better understand the topic of climate change. Both MOOCs did undergo a questionnaire survey to participants on competence-based evaluation to review which learning outcomes have been achieved. In our paper, we compare and contrast the learning outcomes of both MOOCs. The results clearly indicate that taking part in either of the MOOCs increased the participants' competences to critically engage in the climate change debate. Almost all participants stated that the MOOCs have increased their level of knowledge and that they would like to further occupy themselves with the topic of climate change. These outcomes strengthened our confidence that MOOCs could be used as a tool that can empower people to critical climate thinking.

The adoption of sustainability assessment and indicators to INSPIRE sustainable development in a higher education context

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Abstract

The concept of sustainable development is increasingly being used as a framework and planning tool for better decision making, with the aim of creating more benefit with less resource. Indeed, if employed effectively, sustainability assessment and indicators can be used for capacity building and to enable future proofed, resilient decision making for a more sustainable future. The University of Wales Trinity Saint David (UWTSD) has placed sustainability at the core of its strategic planning process, embedding sustainability within its core operations and culture. The seven core values (key performance indicators) of the University as outlined in its Strategic Plan (2013 to 2017) include sustainable development. This has acted as a catalyst for embedding sustainability through the University's Institute of Sustainable Practice, Innovation and Resource Effectiveness (INSPIRE) as a core principle across all aspects of the University, from campus and student-led initiatives to pedagogy developments. Pedagogy developments have been achieved through a system-based approach to delivering meaningful and relevant educational pathways, promoting learning and social responsibility that supports 'development that meets the needs of the present without compromising the ability of future generations to meet their own needs' (World Commission on Environment and Development, 1987). In this paper the author explores the role of the University's formal and strategic sustainability assessment and key performance indicators in supporting the embedding of sustainability in its learning and teaching programmes and presents feedback from academics on how effective they believe strategic indicators are at promoting resiliency in education for sustainable development.

Keywords: Education for Sustainable Development, Assessment, Indicators, Pedagogy, Strategy

How to implement a Holistic Curricula Reformulation Process? Experiment With The Dragon Dreaming Method For Embedding Sustainability at the Portuguese Distance Learning University

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Abstract

Within the challenges for sustainability implementation in higher education, curricula reformulation is seen as a cornerstone to respond to the transition quest towards more sustainable societies. In order to prepare the students for the complex socio-ecological and economic challenges current and future generations are facing, universities are requested to adapt their teaching mission and educational formats. While research in this field has advanced in the last decades and an increasing number of universities have started to include sustainability in their curricula, there is still little knowledge how to start a holistic curricula reformulation process. Addressing the whole academic community and embedding sustainability in all courses offered instead of adding the topic only in some specific courses or areas represents a still difficult task for many universities. Universidade Aberta (UAb), the public Portuguese distance learning university, has already a formal educational offer in in environmental/sustainability sciences, taught in bachelor, master and PhD programmes, as well as in non-formal courses (life long learning and MOOC - Massive Open Online Courses). Nevertheless, UAb followed the call for continuing transformative approaches and opted to experiment with the collaborative method *Dragon Dreaming* to embed sustainability in all its educational offers. This case study research aims to offer insights from Universidade Aberta's process that includes workshops and Teach-the-Teacher-Events, providing practical knowledge on several levels, e.g.: (i) engaging all stakeholders, including external groups, (ii) guiding an open dialogue to develop a shared vision on sustainability, (iii) curricula reformulation in courses usually regarded as unrelated to sustainability. Findings from interviews and action research along the process show that collaborative methods such as Dragon Dreaming can be useful for developing deep dialogues and engagement. Universities' structures and traditions can constitute barriers to sustainability that might be better overcome with these types of collaborative methods and offer interesting fields for further experiments and research. Results from the workshops are presented, namely a proposal plan for a holistic curricula reformulation and teachers training as well as proposals of how to overcome the main barriers usually found in these processes.

Key-words: Dragon Dreaming, curricula reformulation, Universidade Aberta, sustainability implementation, higher education

Sustainability and Distance Learning in Higher Education: rethinking the model

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Abstract

Higher Education is experiencing disruption from technologies, demographics, the globalizing world and human expectations of life. Whereas Higher Education used to be the minority requirement for an educated 'elite', today it is becoming the expectation of the population as a whole. As students become 'everyone' and learning becomes 'all the time' Distance Teaching and Research Institutions have a tremendous opportunity but there are also many disruptions. Innovations in the way we work, changes to the environment and the effects of globalization create deep and urgent requirements for thoughtful people in all professions and vocations. Sustainability could be argued to be the deepest of the deep issues of our time. Higher Education can contribute to sustainability in many ways – social, technical and environmental; globally and locally. But what will this contribution look like? In this paper the responses from senior leaders in the four universities involved are presented, compared and discussed. Interviews were conducted to the rectors of the four European Distance Learning Universities in UK, German, Spain and Portugal, and the following questions were asked: What is the current strategic vision of the University to meet the challenges of the next 20 years? Is it 'business as usual' for HE or can we expect to see dramatic change? How does the University's strategy contribute to the specific international challenge of sustainable development in its many guises? What are the likely future for MOOCs? Is distance learning going to remain the preserve of a few specialized agencies or do you think it will become more widely provided by other agencies? As country and language boundaries change – how important is a sense of place to the University? The conclusions draw out some strategic imperatives for sustainable higher education in the twenty first century. This project is part of a European collaboration between four distance-teaching universities.

Keywords: Distance learning, Higher Education, sustainability, globalization

The power of art to foster systems thinking, one of the key competencies of education for sustainable development

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Abstract

Systems thinking is one of the most difficult competencies to acquire for students (Mingers, 2015; Arnold & Wade, 2015). Nevertheless it is one of the key competences of education for sustainable development (Wiek et al, 2011; Fiksel, 2012). Although there is not a lot of research available on the link between didactic approaches and sustainability competencies (Waas, et al, 2012) it is clear that alternative ways of teaching, such as project based learning and multi-perspective and interdisciplinary thinking and working are more effective to acquire this competency (Holgaard et al, 2016). In this paper, however, we want to explore the effectiveness of art as a way to foster systems thinking and to distinguish between different ways of thinking about sustainability. A bottom-up way of thinking is explained through the use of paintings by René Magritte and Maurits Escher to contrast it with a top-down approach. Although arts are essential in promoting critical inquiry of environmental awareness and sustainability (Clark & Button, 2011, p. 42), Magritte and Escher did not paint for this purpose. Nevertheless their paintings were very helpful to communicate concepts in relation to a bottom-up and top-down way of thinking about sustainability (Molderez, 2003, 2008). They emphasize the importance of borders which is also relevant in an ecological context. We therefore used the paintings because of their power to inform, according to Eisner (referred to by Finley, 2005), an important contribution of art.

Key Concepts: Systems thinking, sustainable competencies, sustainable development, art, top-down, bottom up

A top-down versus bottom-up view of the relationship between system and environment

Top-down versus bottom-up goes back to two modes of thought that existed in pre-Socratic times (4th-5th century B.C.). Robert Chia (1996a: 34-35) refers to Heraclitus and Parmenides. While Heraclitus emphasised the primacy of flux and transformation, his successor Parmenides insisted upon the permanent and unchangeable nature of reality. Heraclitus was convinced that reality is multiple, heterogeneous and always changing. Parmenides saw one world which is constituted and unchanging. In our own time, these ideas have been discussed in great depth by Alfred North Whitehead (1929). This distinction has been given different names by different authors, as in *strong* and *weak* by Gianni Vattimo (1988), the *already* and the *un-ready* by Robert Cooper (1993), *being* and *becoming* by Robert Chia (1995, 1996a, 1996b), *distal* and *proximal* by Robert Cooper and John Law (1995).

A top-down approach of a man's role in the world is one where man, in a metaphorical way, sits on top, above everything else, considering all as mere material at one's disposal. Man, as any other system, is *within* the environment, in the centre of everything. This position makes it easy to tell others what to do. Different steps are distinguished to be able to reach a goal that is fixed beforehand. System and environment are identified as separate entities which facilitates considering them as static, as entities that are finished, ready. The boundary functions as a way to separate system and environment. The emphasis within this way of thinking is on problem-solving. One starts from problems that can and must be solved, which corresponds with Arne Naess's (1973) concept of shallow ecology.

A bottom-up approach implies essentially being *with* the environment, in togetherness. The boundary between the system and environment is binding the two elements. It stresses the bond between the two. The boundary joins the two elements together. It shows that there is a link, a connection with something, with another. The bottom-up approach focuses on organising as a process of creating meaning in action and therefore makes the division between system and environment rather problematic. Everything starts at the bottom, or where the core of activity of life is. When one is part of this activity, it becomes difficult to disentangle the different elements. One is trying to create a provisional whole. This whole is unknown and therefore impossible to be defined in advance. It also reveals that ecology goes further than solving problems of waste. In Naess's (1973) reading it is about deep ecology, i.e. asking questions all the time in the sense of "is the way we live now the way we want to live".

The table summarizes the main characteristics of a top-down and bottom-up way of thinking about the relationship between system and environment.

Table: Top-down and bottom-up: two ways of thinking about the relationship between system and environment

Top-down	**Bottom-up**
System is *within* the environment	System is *with* the environment
System and environment are entities, ready	Relations between system and environment, unready
Telling others what to do, goals as end	Being in the midst of, where the action is; trying to create a provisional whole
Problem solving	Questioning, reflecting about the way we live now

Sustainability as top-down and bottom-up

Sustainable development is an example of a concept which is mainly injected into our language system via politics. As a result, it particularly bears the marks of a top-down approach. At first, especially policymakers from the public sector are familiar with sustainability. It is relatively unknown for the other actors. Once the concept has settled on the bottom, little remains from the original concept. In its descent, the concept is influenced and transformed by unforeseen forces. These changes are not necessarily problematic, because a living concept is susceptible to changes. Attempts to fossilise ideas are doomed to fail, because: "the linguistic river never stops flowing" (Saussure, 1983: 139).

According to Linda Starke (1990: 8-9) it is unclear who conceived sustainable development. It was an important concept in the title of a key paper for the eighties, i.e. the World Conservation Strategy: Living Resource Conservation for Sustainable Development from 1980. This paper was jointly published by the International Union for Conservation of Nature and Natural Resources (IUCN), the United Nations Environment Programme (UNEP) and the World Wildlife Fund (WWF). Sustainable development was defined as follows: "For development to be sustainable it must take account of social and ecological factors, as well as economic ones; of the living and non-living resource base; and of the long term as well as the short term advantages and disadvantages of alternative actions" (cf. Allen, 1980, main volume). Our Common Future, the report of 'The World Commission on Environment and Development' (1987: 43, ix) made the concept generally known and widely used. Here, sustainable development was subscribed as: "a development which meets the needs of the present without compromising the ability of future generations to meet their own needs". This Commission was installed in 1983. Chairman was Gro Harlem Brundtland, hence the often used name Brundtland Commission. At that time she was leader of the Norwegian Labour Party. When she became Prime Minister of Norway in 1986, the Commission received much more attention. The final report was released in London on 27th April 1987.

The definition of The World Commission on Environment and Development fits a top-down approach. Man is still in the centre of everything, but he needs to preserve nature out of self-interest. The commission originated out of a growing international concern about the global environmental problems and the welfare gap between North and South. The idea was that these problems could only be solved by striving for sustainable development. The starting point was that economic and social development has to take place within the boundaries of the environment. Global sustainable development made a repartition of welfare between North and South necessary. The analysis of the Commission urged for a follow-up. This was the United Nations Conference on Environment and Development (UNCED), which took place in Rio de Janeiro in 1992. One of the results was Agenda 21, an ambitious plan of work for the future. It contains a set of measures that are necessary to obtain world-wide sustainable development for the twenty-first century. The report asks rich countries to change their consumption and production patterns, because their demand on the global resources is too big. According to Agenda 21, space will be created for the South if the rich countries take a smaller claim of the environmental space that is used. Successive conferences such as Rio+10, Rio+20 show that the realisation of the imposed objectives is difficult for these rich countries. Despite the progress the objectives cannot be reached in time.

From this top-down perspective, equal distribution of natural resources is the point of departure. This is a rather simplistic view. The environment is seen as a certain quantity, which should be equally divided among the so-called rightful claimants. Everyone is entitled to an equal part of the environment. This definition originates from a static way of thinking. A distinction is made between environment and people. Great importance is attached to international co-operation, because environmental problems are not limited to the borders of a country. On the other hand, the boundary between environment and man, economy and ecology is maintained. Certain people want to abolish the borders (between countries), while others do not realise that the boundaries between environment and man are a problem.

Sustainable development deals with the so-called ecological challenges that we face today, but we are only beginning to feel the consequences of man's actions on a large scale. If one takes problems as a starting point, one might react too late. Solving problems when they occur is a short-term policy which is contradictory to the long-term perspective that is at the base of sustainable development. Think of the distinction between environmental measures to combat pollution versus questioning a society of continuous growth and consumption and reorganizing that society towards a different way of consumption.

One often refers to a so-called implementation gap; the concept of sustainability is vague and the knowledge to realise sustainable development is lacking. Implementation as the next phase is required if one perceives sustainability as an objective. One needs to come up with steps to obtain this goal.

Describing sustainability in function of interests and the realisation of certain needs connects with objectives, goals or ideals to strive for. As an abstract ideal, it is more or less like a utopia, disconnected from everything. It is almost always considered as a final ending, something one can reach after progressing through different stages. Sustainability fits in a framework of causality. When certain actions are taken, sustainability can be reached. Sustainability as top-down is a linear process. After several steps have been taken, one comes closer to the goal. Finishing stresses a particular moment in time, the chronological end, the last point. After more than twenty years of reports and summits, the goal ‘sustainability’ hasn’t been reached yet, though. Nobody can wait more than twenty years before the goal of sustainability is obtained.

While an end is also a goal, an objective, a purpose, seeing an end in a much broader way allows it to be an integral part of the system. The end is open, not only in the sense of an open end. The openness of an end emphasises the completion and the process, but also the possibility for an individual to add to the story during the very unfolding of the story. And this relates to a bottom-up way of thinking.

Combining end with process is relevant to sustainability. Sustainability as a process instead of a goal emphasises simultaneous reflection and action. This bottom-up approach of sustainability is less emphasised in literature. Sustainability originates from actions of forest workers. In the beginning of the twentieth century, an association was made between the term and natural resources, but then it was only linked to forestry. Recknagel and Bentley (1919, referred to by Simpson and Weiner in The Oxford English Dictionary, 1989) wrote in 'Forest Management' that: "By sustained yield is understood the yield or cut of timber from a forest which is managed in such a way as to permit the removal of an approximately equal volume of timber". In other words, it is the amount that can be periodically harvested without long term depletion. This definition relates with the conception of language as based on the activity of people in a community (Saussure, 1983). Consider the well-know case of rubber tappers in 1980s in the Brazilian rainforest, led by Chico Mendez (Hochstetler & Keck, 2007). Using traditional knowledge, rubber tappers harvested rubber in a sustainable manner as opposed to convential methods of the time that led to deforestation in the Amazon. Mendez used sustainable development in the sense of protecting the rainforest in a way that it is also beneficial to the poor, local people in terms of income. In this way, the case is representative of a bottom-up approach to sustainable development. The rubber tappers are acting as a system that is *with* the environment. Sustainability was not perceived as a goal by them, but was part of their entire approach to tapping rubber. Their typical way of rubber tapping emerged from being in the midst of the forest. They were with the forest and did not see it as a source to possess and to exploit. Being in the midst of activity made it difficult for them to distinguish between people, planet, prosperity. Sustainability occurs in the interface. Sustainability cannot be seen in isolation. It is above all (in) activity and something that never stops. Acting directly in the midst of the forest produced a way of working which implicitly involved the idea of process.

Unfortunately, Mendez was killed on December 22nd, 1988 by two large landowners. But his legacy lived on, and traditional rubber tapping methods are being appreciated again in Brazil for the long-term capacity they offer.

At that time, within a time span of one year, the rubber tappers in Brazil and the report by the Brundtland Commission got a lot of media attention. Two different approaches of sustainability became visible.

Art as another way to understand a bottom-up and top-down approach of sustainability

Top-down and bottom-up approaches of sustainability can be perceived as a dualism. In a classic reading of dualisms one of the parts is often suppressed by the other (Molderez, 2008). Dualisms as divisions create a dilemma. Because there are two parts a choice is forced. And the one that is not chosen is often forgotten. This is the case for a bottom-up way of thinking. Despite its value, this approach of sustainability is not well-known. Students are not familiar with the two. Because sustainability is also about diversity and creativity, it also needs different ways of teaching. We have used two paintings from well-known painters, René Magritte and Maurits Escher, to explain how a bottom-up differs from a top-down approach of sustainability in a course related to corporate social responsibility. Sustainability is focussing on the relationship between system (a company for example) and environment. But this relationship can be one of dominance or of accepting diversity.

How the boundary between system and environment is conceptualised is a pivotal word to distinguish a top-down from a bottom-up way of thinking about sustainability.

Art can help to explore the meaning of a boundary between system and environment, i.e. as disconnecting, connecting or both. Art and artists are usually years ahead of science. True great scientists often admit that most or all of their success is due to imagination. Not considering artists and writers as a possible source of inspiration is part of the construction of divisions between disciplines. In a transdisciplinary course, ideas are emphasized whatever their origin.

The Belgian painter René Magritte disliked to be called an artist. He preferred to be considered a thinker who communicated by means of paint. His paintings have gained recognition for problematising dualisms and boundaries.

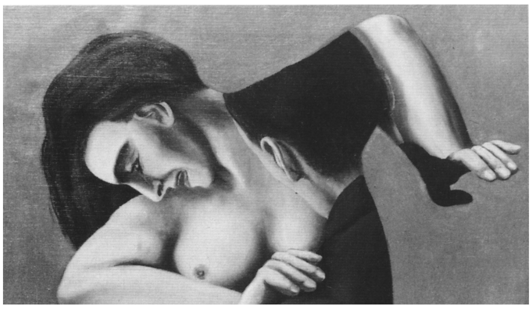
René Magritte's painting *Les Jours Gigantesques* from 1928 is a source of inspiration and safeguard for the ideas developed about a bottom-up approach of sustainability. It shows how difficult it is to make a division between two entities, in this case man and woman. Man and women symbolise system and environment. Although one can see that it is about a man and a woman, it is unclear where the woman ends and the man begins. The joining between the two makes this undecidable. The function of the boundary is not to separate man and woman. It symbolises that they share something, a *being together*. They are not really the same, nor completely different. To use Deleuze and Parnet (1989: 3), it is *the woman-becoming of man* and *the man-becoming of woman*. This does not imply that man and woman result in a kind of hybrid, or something in-between which is also a no-thing. We know man and woman only through the relationship between them. Both are in interplay with each other. *The other* is important and necessary. So the painting clearly shows that it is about system with the environment. Both are needed at the same time.

Magritte's creative impulse for this painting was a man raping a woman. In *Les Jours Gigantesques* this violent act is not one of victory. Man is not suffocating woman. The painting shows a very tense and vulnerable relationship.

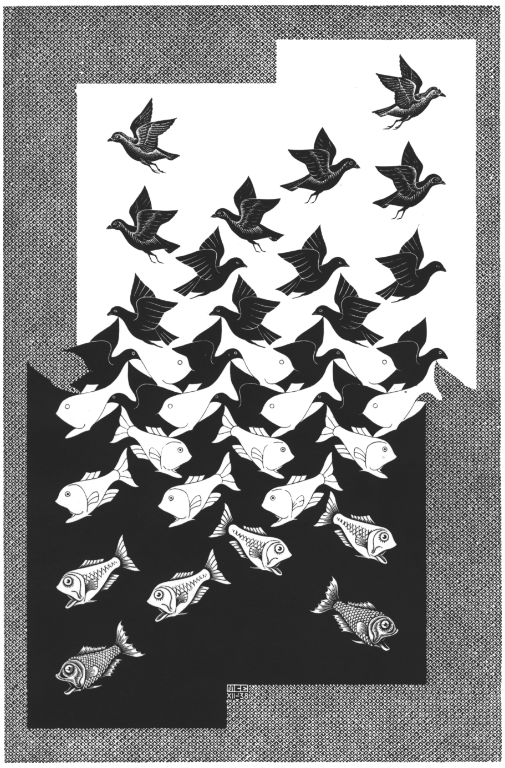
Les Jours Gigantesques is about movement and production. Contact brings forth tact and care, but also anger and fear. It is never either the one *or* the other, but *both* at the same time. Consequently *one* cannot claim that the output belongs to him or her only. The output is created in activity and therefore belongs to every part.

The importance of the boundary is also illustrated in Maurits Escher's symmetry work *Air and water II*. It is characterised by a play between foreground and background: "Our eyes never see a continuous pattern but fix their attention either on the one or on the other" (Escher, 1989: 35). Not only the oscillation between foreground and background is intellectually stimulating. Foreground becomes background and background foreground where the contours of birds and fish are, where they meet or where the border is. The border does not belong to the one or the other, but differentiates between the two. A bottom-up appraoch is again visible. The fish is with the bird. The fish is formed by the touching of the bird and vice versa. Both are needed to be able to exist. Again the function of the boundary as binding is represented. A boundary within a bottom-up approach is not a split between two entities, but a way to connect, to form and to give meaning to two parts that are trying to form a provisional whole.

'Les Jours Gigantesques' by René Magritte (Sylvester & Whitfield, 1992: 276 – 277).



Air and water II', by Maurits Escher, (1990).



Students' responsiveness of using art in a course on corporate social responsibility

Using art to explain different approaches of sustainability is not widely practised in courses on sustainability. A survey to higher business education students carried out during a course on corporate social responsibility showed that they were not used to this way of lecturing. For more than 70% of the students it was the first time that art had been used in a course to explain a concept. The courses that did use art were related with psychology, a discipline that often deals with the act of suppression and perception which is easily shown by images.

Despite the unknown, 74% of the students found the paintings helpful in better understanding a top-down/bottom-up approach of sustainability. Main arguments were the following: images tell more than words, using art adds to diversity, leads towards the acceptance of different opinions, stimulates to think, helps you to see things from another perspective, using paintings is more fun to learn about the differences, it broadens your frame of reference, is useful to explain more abstract concepts, is creative, is less black/white thinking. A minority of students who were rather negative about the value of arts argued that it is not good to use art because of its many interpretations. This adds to confusion according to them. They also argue that art is not accessible for students who are not creative.

According to the students *Air and Water II* was the easiest painting to understand and to link it with a bottom-up approach of sustainability. One fifth of the students answered that *Les Jours Gigantesques* did not help them at all. An overwhelming majority although perceived Magritte's painting as an eye-opener and a helpful way to better understand the different elements of top-down/bottom-up.

To conclude

The purpose of the distinction between a top-down and a bottom-up approach is not to qualify the one with good and the other with bad. That would imply a top-down reading of these two approaches which is in contradiction with the argument built up in the paper. There is room for both at the same time. But often only one conceptualisation of sustainability, i.e. a top-down approach dominates. This paper wanted to emphasize the relevance of a bottom-up approach by using art. Firstly, bottom-up adds to a diversity of other ways of thinking. Secondly, it corresponds with another way of organising, i.e. with tact and care because the other is dear to you without the aim of reaching a particular goal or end that is known in advance. Activity creates an end, instead of imposing it top-downwards.

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Influences on tertiary students learning for sustainability: results of a multi-university EfS research study

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Abstract

Tertiary education institutions can play a major role in contributing towards more sustainable cities and societies through their curriculum, campus sustainability initiatives, research projects and community engagement activities. Indeed, institutions have begun to embed sustainability into key functional areas, including the curriculum. Previous case studies report the impact of specialised sustainability courses as well as integration of sustainability elements and pedagogy into mainstream courses in business, engineering, design, education, etc. However, these relate to specific interventions in particular institutions and there is a lack of empirical studies using a common instrument to report student learning and behaviour, which represents a gap in knowledge. This paper reports the results of two-year, international multi-university Education for Sustainability (EfS) research study, using a common instrument to identify students views, attitudes and behaviour for sustainability and the influence of various EfS interventions. The study is guided by the Value-Belief-Norm (VBN) theory of environmentalism proposed by Stern (2000). The VBN model links value theory, specifically environmental worldviews (measured by Inclusion of Nature in Self scale (INS; Schultz, 2001), to beliefs (measured by New Environmental Paradigm (NEP; Dunlap, 2000)), norm-activation theory and environmental behaviour. This model indicates possible points of intervention by tertiary education in both formal learning (via the curriculum) and informal learning (via campus operations and community engagement) for sustainability. The research also investigated the role of demographic, cultural and educational influences on tertiary students "sustainability profile", comprising elements of their knowledge, attitudes and behaviours towards sustainability. Research data was collected during 2013-2015 across 9 tertiary institutions in Australia, Malaysia and Italy. For each institution, data was collected in an online pre-test survey (Stage1) at the beginning of term/semester and a post-test survey (Stage 2) at the end. The study comprised both "intervention groups" where sustainability concepts were introduced and discussed during the term and "control groups" where no sustainability concepts were introduced. Survey data was analysed cross-sectionally to investigate underlying differences in student responses at the beginning of term/semester and also longitudinally to detect any influence of EfS during the term/semester. Cross sectional analyses reveal differences in tertiary students "sustainability profiles" influenced by gender, age and "culture". Findings of longitudinal analyses indicate differential impacts of EfS interventions on students' sustainability attitudes and behaviour. The paper provides an insight into the coherence and convergence of tertiary students "sustainability profiles" and highlights factors that mediate and moderate their learning for sustainability in a higher education setting. These findings have implications for higher educational policy and teaching praxis.

Keywords: personal sustainability profile; formal and informal learning for sustainability; Higher Education for Sustainable Development; cognitive, affective and conative domains of learning; Education for Sustainability, environmental worldviews and behaviours

Education for Sustainable Development in Higher Education Institutional framework: The Portuguese practices

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Abstract

There have been several integrated studies conducted in Europe, mostly in northern and eastern countries to evaluate how Education for Sustainable Development (EDS) has been applied in the institutional frameworks of Higher Education Institutions (HEI). Nevertheless in Portugal there were still no attempts to evaluate how HEI and the government have been incorporating Education for Sustainable Development (ESD) in their programs, and strategic and development policies. The aim of this study was to determine how sustainability was integrated into policies and strategies of HEI, in particular in the 15 Public Universities in Portugal, within the framework and goals of the United Nations Decade of Education for Sustainable Development (DEDS) 2005-2014. A deductive approach was carried based on grounded theory strategy, multi case studies and documentary content analysis. Pre-selected key terms based on literature search were used for the content analysis, namely the following: a) DEDS – Decade for Education for Sustainable Development, b) Sustainable Development; c) Sustainability/Sustainable, d) Environment/Environmental, e) Higher Education/Universities. Documentary research was conducted on: i) the plans from the Portuguese Government (periodic Great Planning Options (GPO) and Governmental Constitutional Plans (GCP), ii) the policies and strategies of the Ministry of Education and Science; iii) the Strategic Plans, Plans and Reports of Activities, Sustainability Reports produced by the 15 Portuguese universities that belong to the Portuguese University Rectors Council. The documents were analyzed during the period of the DEDS (2005-2014), to better understand the compromises assumed concerning EDS and analyze the possible forms of implementation the goals of DEDS and their consequent impacts on strategies of the public University Institutions. An analysis to all the formal programs names related to sustainability, credited by the National Agency for Assessment and Accreditation (A3ES) in Portugal from 2005 to 2014 was also conducted, to give an overall overview of how sustainable development is being integrated in the curricula. Preliminary results shown that EDS is still in early stages of development, not only at government level but also at Ministry and Universities levels, and there is a lack of national integrated strategies or policies, besides some international drivers and singular and few good examples at University levels. For example only two Universities published sustainable reports and only 5 signed the Copernicus Chapter. For the effectiveness of the processes concerning Education for Sustainable Development, commitment to the implementation of public policy and sustainability at the level of HEI is of crucial importance. There is an absolute need for a change in the paradigm and characteristics of Portuguese HEI and still several barriers to overcome, learning from good practices already in place in other European and worldwide countries. Future studies will be conducted with a detailed questionnaire survey to be applied to the Portuguese Universities within this context and in order to further progresses in these research questions.

Keywords: DEDS – Decade for Education for Sustainable Development, Environment/Environmental, Sustainability/Sustainable, Sustainable Development, Universities.

Toward a sustainable society: Cultivating Sufficiency-Mindset in Thai schools

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Abstract

This paper examines how Thailand promotes education for sustainable development; it is known as the sufficiency-based school movement. The sufficiency-based schools apply the principles of His Majesty the King of Thailand's Sufficiency Economy Philosophy (SEP) in a whole-school approach manner. SEP offers a decision making framework based on three principles - moderation, reasonableness, and prudence - along with two conditions of virtues and knowledge, while addressing balance development of environmental, social, cultural, and economic progress. SEP school movement aim to cultivate sufficiency mindset and practices in students' daily lives by embedding SEP in the curriculum and school activities in age-appropriate ways. The movement also encourages school administrators to role model the principles, and expand to community partnerships. More than 18,699 out of approximately 40,000 schools in Thailand have been certified as sufficiency-based. 68 accredited Sufficiency Educational Learning Centres (SELCs) help mentoring applicant schools. Two phases of research were conducted. The first phase qualitative research studied the practices, success factors, and outcomes of nine SELCs. The second phase survey research studied 178 schools to evaluate the outcomes and their relationship with sufficiency-based school practices identified in the first phase. Outcomes of students in grade 6, 9, and 12 in different categories of sufficiency-based schools (the first level category, the second level 'Best practice' category, and SELCs) were studied. The first phase findings uncovered five key SELC practices: readiness preparation of sufficiency learning; sufficiency based curriculum; wide-ranging school activities; encouraging sufficiency habits in individuals and the community; and program expansion to other schools and communities. Furthermore, the key success factors include: faith in sufficiency principles, shared personal characters based on SEP, professional development of staff; expertise in sustainability education; a sustainability curriculum; an enabling environment, multi-stakeholder partnerships; and focusing on socio-cultural dimensions of sustainability rather than a sole focus on 'green' agendas. The second phase findings revealed higher averaged Ordinary National Educational Test (O-NET) scores of students from sufficiency-based schools than the averaged national standard in 2008, 2011, 2014 (excepting Grade 12 student scores in 2008). Sufficiency-based school students had a higher level of proficiency than students in other schools in five competencies (life skill, communication, logical thinking, problem solving and IT literacy) and nine desired characters (sufficient living, good citizenship, willingness to learn, integrity, diligence, discipline, healthy body and mind, local heritage pride, and national loyalty), excepting the grade 12 students in the first level sufficiency-based schools. Local communities where sufficiency-based schools were situated had a higher level of changes and satisfaction than other communities. SELCs and BP schools received very high scores in all five key practices, identified in the first phase. Other non-SEP schools received very high scores in only three practices, excepting curriculum and networking to expand results. The study found <u>*curriculum*</u> to be positively related to the O-NET scores for grade 9 and grade 12 students, and the desired character of grade 12 students. The <u>*network expansion*</u> is found related to competencies and characters of grade 9 students and community satisfaction. Finally, challenges for the future of the sufficiency movement in Thai schools are discussed.

Keywords: sustainability, sufficiency economy, schools, Thailand

1. Introduction

1.1 Education for Sustainable Development

Integrating human capability development and sustainability is a new global agenda (Coate, 2009; Hopwood, Mellor and O'Brien, 2005). Sustainable development calls for our mindsets and values to be transformed and changing how we act with the environment and society. Education for Sustainable Development (EfSD) allows every human being to learn the values, behaviours and lifestyles necessary to shape a sustainable world (UN General Assembly, 2002). It is a global campaign that reflects a vision for the world where everyone can benefit from a sustainable future. The aim is to build capacity for community-based decision-making, environmental stewardship, social tolerance, an adaptable workforce and improved quality of life for all, using techniques that promote participatory learning and informed thinking.

A number of school sustainability programs have been studied to examine critical success factors. From a document and evidence review of five international sustainable school programs in New Zealand, Sweden and China (Henderson and Tilbury, 2004), whole-school approaches to sustainability was found to have an important contribution to make in shifting the communities towards sustainability. It revealed key features of sustainable schools to include the following: alignment with national government agendas and sustainable education approaches; access to expertise in sustainable education; significant and on-going funding; investment in professional development of program team members and school partners; establishment of multi-stakeholder partnerships; and creating links with existing sustainable education initiatives.

According to the later report on the UN Decade of Education for Sustainable Development (Wals, 2012), key elements of sustainable schools include the following. Sustainable education requires integrative, problem-based, and exploratory forms of learning that invite participants to be critical, creative and change-oriented. Furthermore, schools should implement whole-school approaches with sustainability practices in all aspects of school activities and everyone's lives. The report further identifies visionary leadership, high levels of participation, social networking, and new forms of action-oriented research as key features of sustainable schools. Despite an increase of research on sustainable school programs, there is a lack of research to evaluate their effectiveness.

1.2 Sufficiency-based schools: cultivating sustainability mindset in Thai students

In Thailand, a determine efforts has been made to apply the principles of His Majesty the King's Sufficiency Economy Philosophy (SEP) in the national education system. SEP is a decision-making framework that can guide us in living sustainably. SEP is based on three practical principles of moderation, reasonableness, and prudence – along with two conditions of knowledge and virtues (Wibulswasdi*,* Piboolsravut and Pootrakool*, 2010)*. They translate into appropriate ways to solve problems or take actions indifferent situations. SEP stresses balance in the use of material, social, environment, and cultural capital, while underlining the importance of preparedness in dealing with changes in these four dimensions. Progress with balance promotes stability and, ultimately, provides a basis for sustainability. That can be true for national development programs as for our life agendas.

The aim of the SEP campaign for education reform in Thailand is to promote sustainability mindset and practices as a basis for national development. As of December 2015, of the approximately 40,000 primary and secondary schools in Thailand, nearly 18,699 have been certified as having successfully integrated the sufficiency economy philosophy as a practical orientation in teaching. At the level of individual student behaviours—the focus of the reform—the aim has been to cultivate SEP-based mindset and practices in young students in the name of building a sustainable society. The holistic approach of SEP schools impacts the 'head, heart and hands' of students—the intellectual, spiritual and practical aspects of education. SEP schools seek to cultivate attitudes that will help students to form lifelong habits of thinking and doing that support sustainability in society in general. Students are encouraged to develop a sufficiency perspective for living a self-reliant and balanced lifestyle. Curricular goal aim to develop a moral and ethical outlook associated with a disciplined approach that reflects virtues. The SEP-imbued curriculum also includes decision-making principles. Students should use reasoning in applying knowledge, with prudence and carefulness, in order to contribute their share of school and community benefits. In these schools, learning through doing (questioning, planning, acting, and reflecting) and developing sufficiency-based decision-making and interest in local and global knowledge are essential.

From the start, these schools have a curriculum that can instil SEP-based behavioural principles in students. However, classroom teaching alone was insufficient to change thinking and action, so a ‘whole school’ approach has also been developed that applies sufficiency thinking in all school practices, including management, extracurricular student activities and community relations. Two levels of school certification for sufficiency-based school have been established by the Ministry of Education. The first certification level for sufficiency-based schools concerns such a SEP curriculum and a whole school approach. The second type of school certification in SEP exists: Sufficiency Education Learning Centres (SELCs) that can offer teaching, advice, mentoring and supervision to other schools aiming to become sufficiency-accredited. There are sixty-eight SELCs, as of December 2015. In addition to the two formal certification levels, there is also the additional best practice status aims to help sufficiency-based schools in the first certification level further improve the quality of learning activities and management, before reaching the SELC level. The four selection criteria of the best practice status are clear implementation of SEP, innovation and high quality, usefulness for oneself and others, and inspirational content. Those selected for the best practice status receive opportunities for training and participation in various SEP Centre programs.

1.3 Sufficiency-based curriculum

In order to develop students to be virtuous (moral, ethical, with desirable values, disciplined and practising their own faith), the current curriculum has been designed and revised since 2008. Embracing SEP in everyday life, SEP is integrated into eight academic subjects, which focus on the following:

Lower Primary: household.

- G1: learning independence in daily life; sharing with family and friends; learning to save.
- G2: family spending analysis; expense reduction; economical spending.
- G3: helpful, generous, monetary and in-kind sharing.

Higher Primary: group/school.

- G4: household accounting survey; practise SEP-based cooperation.
- G5: SEP applications in school cooperative system.
- G6: practise SEP-based school activities; school situation analysis based on SEP.

Lower Secondary: community level, locality, and province.

- G7: community status and social capital analysis; community history and current problems survey; using SEP methodology to solve community problems.
- G8: stories of SEP and cooperation in local community; applying cooperation to daily life; SEP community case study.
- G9: SEP’s application in community development.

Higher secondary: country and global

G10: background of SEP concepts and royal speeches about SEP.

G11: understanding and applying SEP in economic and social development.

G12: universal understanding and application of SEP.

Teachers use several techniques to integrate SEP into learning activities, and create environments conducive to creating sufficiency-mindsets. Most popular method is the "QPAR model", developed by the Ministry of Education's SEP working group. It is a cycle of learning, requiring head-heart-hand related activities for balanced learning through experiences, such as assignments, lab-tests, or real-life projects.

Question: Teachers ask students questions within the framework of SEP when designing and implementing learning activities, e.g.

- What are we attempting to do?
- Why are we doing this?
- What will be the results if we do this?
- What fundamental ethics will lead to success?
- Are we ready to do this?
- Do we know enough to do the work?
- If not, what type of knowledge do we still need? How can we learn it?
- How will we do this? What is the sequence of actions?
- Are there risks and obstacles?

Plan: Students are encouraged to plan together, learning how to assess and choose among different work plans and sequences before acting.

Action: Sufficiency-based learning is through real experiences and practices, teaching students how to use sufficiency principles in acting with cautiousness, mindfulness, diligence, perseverance, etc.

Reflection: After lessons or activities, students are required to reflect on what they learned, what they hadn't understood, or evaluate the project through the SEP framework. This process is important to nurture the sufficiency mindset through evaluating benefits and values of the SEP.

The process of implementing the learning activities must be moderate, and suit students' capabilities and the school's environment. Projects are assessed on criteria such as whether students have applied knowledge reasonably, based on morality, with prudence and carefulness; the extent of self-reliance; and the school and community benefits of the project. SEP-related projects also need to demonstrably fit the location and local culture, be well planned, include risk assessment, and involve a learning process that develops life skills and morality.

A sufficiency-based curriculum is necessary, but still not sufficient to cultivate suitable mindsets and behaviours. We need a whole-of-school approach, comprising school activities, an enabling environment, a suitable school culture and role models.

1.4 Sufficiency-based school activities

There are four categories of sufficiency-based school activities, which emphasise balanced development among economic activities, teamwork, the environment and culture:

1) "Save & Safe" economic activities are designed to train students to handle money and material resources in a prudent, moderate, realistic manner that allows for the unexpected events, e.g.

- Keeping an income-expenditure balance sheet; adapting spending behaviour towards moderation, developing skills to be financially self-reliant and sufficient.
- Economical use of resources such as water, electricity and fuel.
- Food self-sufficiency in school, involving school lunch programs and integrated farming, extending to households and community.
- Saving activities through cooperative and saving group initiatives in school.

2) "Caring & Sharing" social-team related activities prepare students to be good citizens, be civic-minded and value public- beyond self-interest. Activities focus on cooperation, rather than a narrow mind and self-centredness. Teamwork activities and community development are the main ways of practising necessary social skills such as responsibility, discipline, lawful behaviour and social ethics such as sharing, generosity and honesty. Examples are:

- Moral development programs: Buddhist chanting, meditation, observing precepts, listening to dharma talks, and other religious activities.
- School and community development work: daily school cleaning, community big cleaning day, and volunteer assistance to senior citizens in the community.
- Pride in the national, historic and religious sites, including conservation and renovation work.

3) "Clean & Green" environmental conservation activities enable students to learn to value natural resources such as soil, water, forest, air, and renewable energy, while cooperating in team activities to preserve the environment and reduce unnecessary consumption of resources. Most activities involve studying royal development projects intended to solve local problems. Examples are:

- 3Rs (reduce, reuse, recycle) within the school and community.
- Promotion of environment-friendly knowledge management.
- Learning from royal development works in environmental conservation and restoration, e.g. tree planting, dam building, and soil stabilisation.

4) Community & Cultural activities occur mostly outside school through connections with community and local cultural centres. Students learn about local and national values, and wisdom inherited over the generations. They cultivate pride in their nation, understanding who they are, and where their roots and communities are and come from, while participating in conserving and preserving cultural heritage. Examples are:

- Understanding applications of local wisdom, while developing pride in local traditions.
- Learning about Thai cultural inheritance, Thai and local culture and etiquette, ancient site conservation.
- Respecting different cultures and practising living in harmony in a culturally-diverse society.

After a number of years of sufficiency-based school implementation, there is a need to examine practices used in becoming sufficiency-based schools, outcomes and critical factors in driving success at these schools in Thailand. Furthermore, the relationship or influences of these sufficiency-based school practices on the outcomes when comparing to other schools should be examined.

2. Methods

Two phases of research was conducted. In the first phase, qualitative case study research was utilised to study the practices of nine Sufficiency Educational Learning Centres (SELCs) in facilitating SEP in education. The SELCs chosen ensured variation in school type and size, rural/urban, Buddhist/Christian/Muslim, Thai/other races and wealth. Data sources were documents, school visits, school meeting observations, and interviews with school leaders, administrators, teachers, students and community members. Documents analysed included school reports, schools' training and development documents, schools' quality assessment reports, schools' project reports and documents, school curricula and teaching plans. Content analysis was used to identify themes emerging from the data.

The second phase is the survey research of 178 schools to evaluate the extent of school practice factors identified earlier in Phase 1 and importantly the outcomes. The relationships of school practices and each dimension of outcomes are also tested. Outcomes of students in grade 6, 9, and 12 in different categories of sufficiency-based schools (the first level category, the second level 'Best Practice/BP' category, and SELCs) were studied. The stratified random sampling method was used. 40 responses from schools in the first level category were received. The second level category had responses from 42 schools. 63 SELCs responded to the questionnaires, while 33 other schools (non SEP accredited) participated in the survey study. The context of participating schools was also checked to ensure comparability among each school categories. The survey was sent to the school management, change agent teachers, teachers, students, and community representatives. The data on the universal O-NET (Ordinary National Educational Test) scores of students was also collected.

3. Results

3.1 Findings from Phase 1

The qualitative case studies of nine SELCs revealed that in order to be certified as sufficiency-based school, the headmaster and teachers must work together to prepare themselves and apply through their school district. The voluntary basis of participation in sufficiency school certification reflects an "inside-out" approach to educational development that springs from internal motivation, emanating from the inspirational nature of SEP as a gift from His Majesty the King to his people. SEP training is available to district managers, school directors, and teachers. A career incentive is also built-in to help drive the growth of certified schools. Headmasters and school staff can use their SEP project experience to apply for their career promotion.

A school's journey for sufficiency certification often starts with the aim to improve its management of its limited resources. Only few private schools, where students come from well-to-do families, have ample resources and use SEP to cultivate moderation, sharing and good citizenship in their students. School sufficiency-based activities are extended to the greater community. Volunteers are trained to be the main change agents educating community people, parents and students. SEP applications in daily life include developing attitudes toward moderation in many families and community members. The findings on key practices, success factors and outcomes are discussed next.

3.1.1 Key Practices

The research uncovered the following 5 practices in the development of SELCs:

(1) *Preparation* systematically integrates SEP into whole-school activities, including personnel preparation to cooperatively establish the process. Preparation has 5 elements:

a. Readiness of school management to lead the SEP movement;
b. Readiness of teachers to understand the concept of SEP, share their knowledge, apply sufficiency principles in their classroom lessons, and practise them in their daily lives;
c. Assistance for students to learn in accordance with their abilities, including improving physical health through school lunch programs; providing transport to for needy students to attend school; compassionate, careful responses to mental health problems, misbehaviour, family difficulties, lack of concentration, etc.; and peer tutoring for slower learners;
d. Parents and the local community support the SELC, which requires a continuous process to create understanding in the community;
e. The school's physical environment is adapted for a learning centre.

(2) A *learning management system* follows the sufficiency-based curriculum, including integrative, comprehensive teaching about SEP at every level and in all subjects. Numerous extra-curricular activities enable students to integrate SEP into their daily activities.

(3) *A wide variety of school activities* encourage continuous habits of sufficiency both in school, and at home. This includes studying within and outside school; group activities and activities encouraging discipline, harmony, volunteering, public-spiritedness and mutual help in learning. These activities cover four categories in a balanced way, as discussed above: material, social, environmental and cultural. Senior staff train and inspire new teachers in understanding SEP correctly. Staff development programs in SEP are ongoing; inquiry, sharing and learning are encouraged. Many activities foster relationships with the local community. Parents and others regularly volunteer for activities like co-op saving, recycling, teaching local wisdom, and to work on infrastructure. In return, school administrators, teachers and students participate in and cultural events and community conservation.

(4) The sufficiency approach is *a form of discipline* that brings its own reward. At the individual level, it develops mental and spiritual capacity. Teachers and students with a SEP mindset habitually contemplate sufficiency principles in their everyday activities. At the organisational level, caring and sharing are core values or virtues. Caring for limited resources and the environment results in moderated consumption, while caring for others gives rise to sharing and serving. In general, the SELC process produces high quality civic citizens where principals run their school based on sufficiency principles; teachers have sufficiency values and attitudes; with students' values, attitudes and behaviours based on a sufficiency mindset. Knowledge and wisdom based on sufficiency principles are expected to be used for both self and community benefit.

(5) *SEP program expansion* to other schools and communities: ensuring that SELCs act as learning hubs for expanding the sufficiency-based school system, with staff trained to coach and mentor others.

3.1.2 Key success factors

Internal and external key success factors are identified in this study of selected SELCs in enabling the path towards becoming a sufficiency school and attaining SELC status. Internal factors drive the change and create forward momentum to create sufficiency schools, while external factors build on this success, increasing efficiency.

Three internal key success factors with eight sub-features, indicated in brackets, are listed below:

(1) *Inspiration*, consisting of (1.1) loyalty to the King and (1.2) faith in sufficiency principles. Thailand's monarchy often inspires devotion to work for the nation and society. Thais feel gratitude towards their royals, so loyalty is an integral part of Thai culture.

(2) A shared *personal character* comprising (2.1) accurate understanding of SEP and the ability to apply it suitably and appropriately to changing conditions; (2.2) basic virtues — perseverance, endurance, patience and persistence; and (2.3) benevolence, sharing and public-mindedness.

(3) An *enabling environment* includes (3.1) a harmonious school atmosphere, manifested through a shared vision and ideology among the main stakeholders; (3.2) an inclusive process in which stakeholders participate in driving the sufficiency-based school, using role models; and (3.3) a physical environment that enables behaviour to develop through practice. This enabling environment is critical to supporting the practice of SEP.

There are three key external elements contributing to success in cultivating sufficiency mindsets and forming sufficiency habits. These are: (1) a network of like-minded friends, a community of practitioners; (2) professional development for teachers and others, and policy support from the Ministry of Education; and (3) socio-cultural and religious factors based on important local learning centres and acceptance of socio-cultural and religious diversity.

3.1.3 Outcomes

Results from SEP impacts among students at SELCs include reports of improvement in results from the universal O-NET (Ordinary National Educational Test), of increased student enrolments, and of graduates of SEP schools entering prestigious universities and faculties. Qualitative outcomes from sufficiency-based schools include students demonstrating greater moderation, for example, re-using the reverse side of single-printed pages, volunteerism, courtesy and discipline. Students realize the importance of balancing four dimensions - material, social, spiritual and cultural) in their lives, know how to utilize limited resources, and share with others. They show enhanced analytical and social skills. Students become assertive and self-confident. They participate in and are proud of their local cultural activities. In sum, they are acquiring "21st century skills (e.g. higher-order thinking, creativity and good citizenship.). Interview quotes from parents, university staff and a community member demonstrate these qualitative outcomes.

"Our son was enrolled in the sufficiency school because whatever students learn, they use them to take care of themselves. After class, they do their homework. They help parents with work. So we think that it is good and wanted to enroll him there. At first, I heard from mouth-to-mouth that the teachers teach well. So I think that he should try the new school. So I talked to his father and he agreed."

Parent 1

"Our niece was enrolled in the sufficiency school is because the school teaches children about our ancient traditions. Children are taught to live sufficiently, keep saving and not to spend money extravagantly. They have good habits. The teachers do well in teaching children to preserve Thai traditions and to have knowledge. There are many good things about the school."

Parent 2

"Our university opened quotas for students from sufficiency schools because of the following differences: 1) students from sufficiency schools have clear life goals, 2) they have higher self-confidence to think and speak up, 3) they are leaders in both formal ceremonies such as emcee activities and informal working groups in classes, 4) they know how to plan and they are highly responsible, and 5) they have a volunteer attitude and assist most activities of the university student committee."

University lecturer

"The manners and the greeting from students who are more disciplined while walking to the school are good. Students help collect rubbish. This is from the school's cultivation of students' behaviors toward public goods. They are willing to express themselves more, with morality and humbleness."

Community representative

Interviews with parents of SEP school students reveal that they are satisfied with the results that sufficiency education show in their children, in terms of student development along SEP guidelines. Furthermore, Teachers at SEP schools and community members also demonstrate greater prudence and improved personal management in their finances, and greater engagement and a spirit of volunteering, as the following quotes show.

"I start the changes from self-discipline in taking care of my own health and finances. I think before I buy. I buy only necessary things. I record my income and expenses and save more in my bank account. I know moderation and reduce my own desire. I plan my time and plan my life more. I am more prudent in prioritizing time and importance of things. This makes my family much happier. Before, I was hot-tempered, but now I cool down. I know how to be conscious of my emotion and manage it better. I see value in things which I make myself such as soap and multi-purpose detergent which are good for health and environment. I feel more content with this moderation."

Change agent teacher

"Villagers didn't understand the sufficiency economy in the past. But when the school became a sufficiency school, the villagers started to understand a bit more and follow and apply it in their lives. The villagers have often been invited to meetings at the school and gain more understanding about sufficiency. In school activities, community members also participated, for example, growing banana trees. We can learn from one another and create togetherness and knowledge back to the community."

Community representative

Parents' interview responses indicate that they see the SEP approach working in forging effective partnerships between school and local community. They see the students, school and community working together to identify and solve local problems and issues such as lack of nutritious food and poor health.

3.2 Findings from Phase 2

3.2.1 Quantitative outcomes

The second phase findings focuses on three outcomes: student outcomes (Ordinary National Educational/O-NET Test score difereence bettween years, key competencies, and desired characters); changes to school personnel; and changes to the community. In terms of O-NET resutls, the findings revealed the higher averaged O-NET scores of students from sufficiency schools than the averaged national standard in 2008, 2011, 2014 (excepting Grade 12 student scores in 2008). The results are shown in the Figure 1 and 2 below.

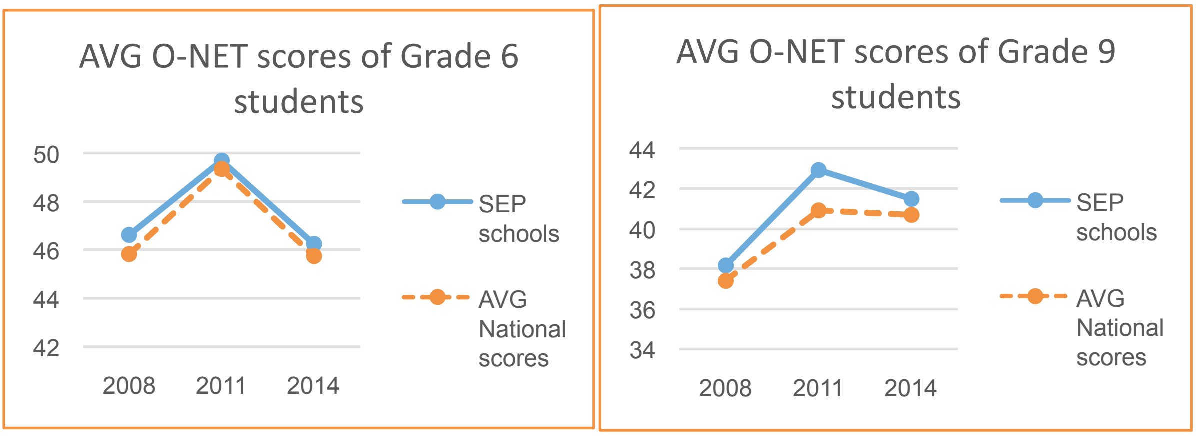

Figure 1. Averaged O-NET scores of Grade 6 and 9 students in 2008, 2011, and 2014

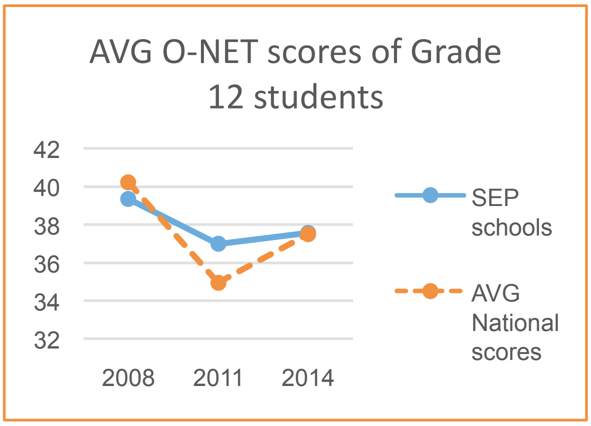

Figure 2. Averaged O-NET scores of Grade 12 students in 2008, 2011, and 2014

When examining the O-NET results by categories of sufficiency-based schools (the first level 'SB' category, the second level 'Best Practice' category, and SELCs), there are variations of results. Some sufifciney-based school catogories were better and some categories were worse than other schools. There is also a variation of results among the three years. However, the SELCs results tend to be more stable, with less drastic flunctuation across three years.

In terms of student competencies, sufficiency-based school students had a higher level of proficiency than students in other schools in all five competencies (life skill, communication, logical thinking, problem solving, and IT literacy). The competency with the highest averaged score from sufficiency-based school learners is the life skill. The competency results are shown in Figure 3. The innermost line belongs to other schools.

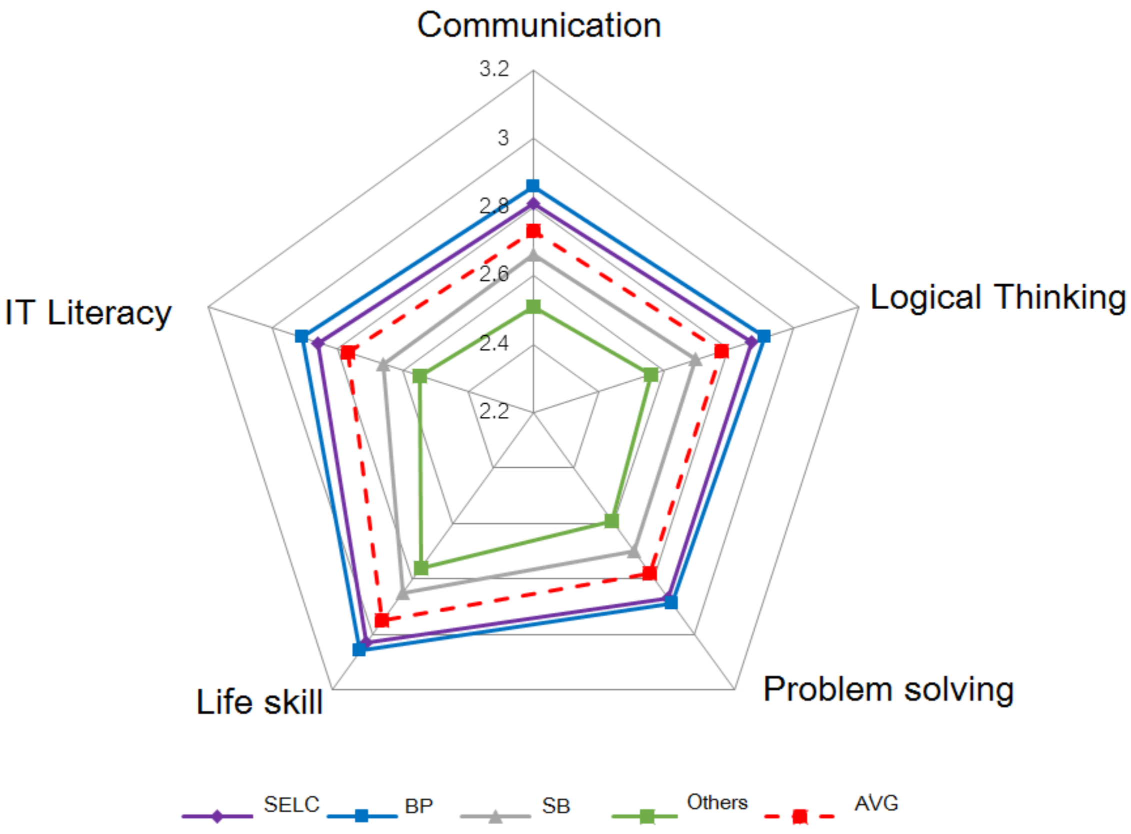

Figure 3. Averaged competency scores of students[10]

When examining the competency results by categories of student year grades, students in Grade 6, 9, and 12 of the BP (the second level of sufficiency-based schools) and SELCs had a higher level of competency proficiency than students in other schools in all five competencies. However, students in Grade 12 in the first level sufficency-based school catogory had a lower level of competency proficiency than students in other schools in all five competencies.

Figure 4 shows that sufficiency-based school students had a higher level of proficiency than students in other schools in all nine student characters (sufficient living, good citizenship, willingness to learn, integrity, diligence, discipline, healthy body and mind, local heritage pride, and national loyalty). The innermost line in Figure 4 belongs to other schools. However, there is an exception with the grade 12 students in the first level sufficiency-based schools, who had lower desired character scores than students in other schools in all nine characters. The character with the highest averaged score from sufficiency-based school learners is the national pride.

[10] SELCs: Sufficiency Educational Learning Centres; BP: the second level ‘Best practice’ sufficiency-based schools; SB: the first level sufficiency-based schools

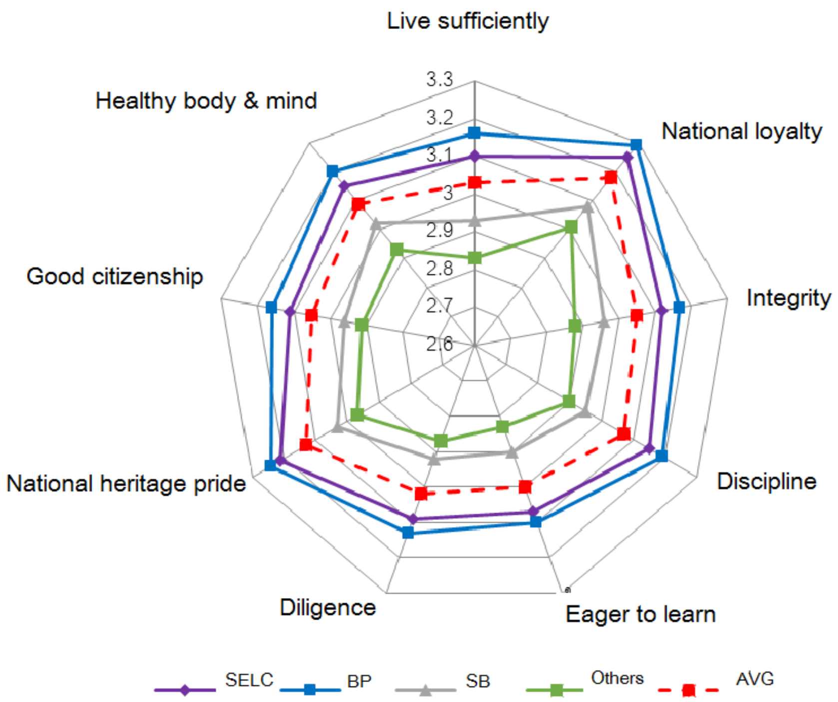

Figure 4. Averaged desired character scores of students

Local communities where sufficiency-based schools were situated had a higher level of changes and community satisfaction than other communities, as Figure 5 show. The innermost line belongs to other schools.

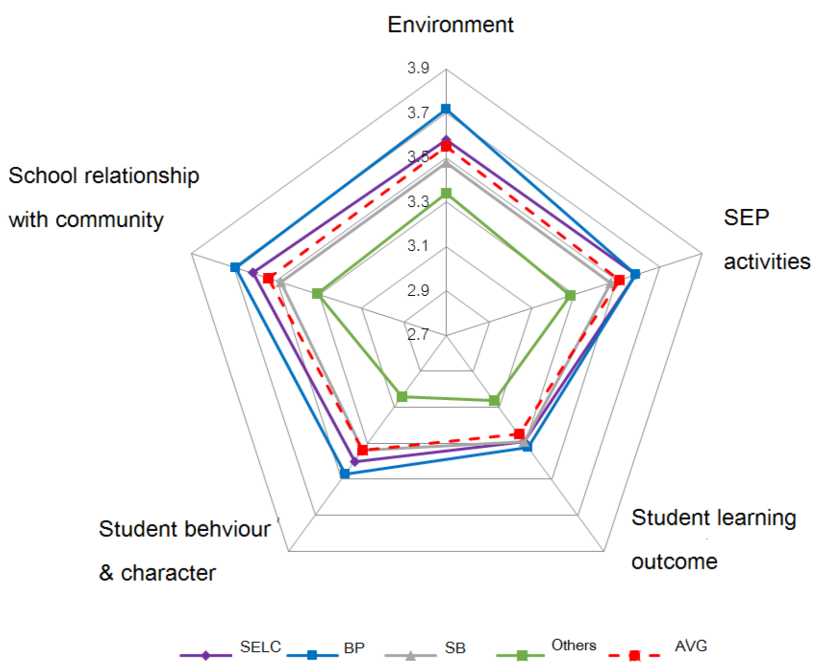

Figure 5. Averaged scores of community satisfaction

3.2.2 Extent of school practices

Table 1 reveals that sufficiency-based schools had practices in following five dimensions: school management, curriculum, learner development activities, staff development, and networking to expand results. SELCs and 'Best Practice' schools received the very high scores in all 5 dimensions, while the first level sufficiency-based school gained very high scores in 4 dimensions, excepting curriculum. Other schools received very high scores in only 3 dimensions, excepting the dimensions of curriculum and networking to expand results.

Table 1. Extent of school practices

Type	Practice	N	Min	Max	Mean	Level	SD	C.V.
SELCs	School Management	63	3.33	4.00	3.93	very high	0.10	2.54
	Curriculum	63	2.73	4.00	3.67	very high	0.22	5.99
	Learner development activities	63	3.42	4.00	3.94	very high	0.11	2.79
	Staff development	63	3.55	4.00	3.98	very high	0.07	1.76
	Network expansion	63	3.66	4.00	3.96	very high	0.08	2.02
	Average total	**63**	**3.59**	**4.00**	**3.89**	**very high**	**0.08**	**2.06**
Best practice schools	School Management	42	3.54	4.00	3.91	very high	0.10	2.56
	Curriculum	42	2.57	4.00	3.59	very high	0.28	7.80
	Learner development activities	42	3.52	4.00	3.88	very high	0.15	3.87
	Staff development	42	3.53	4.00	3.95	very high	0.11	2.78
	Network expansion	42	3.08	4.00	3.88	very high	0.19	4.90
	Average total	**42**	**3.33**	**4.00**	**3.84**	**very high**	**0.14**	**3.65**
First level sufficiency -based schools	School Management	40	3.04	4.00	3.79	very high	0.20	5.28
	Curriculum	40	2.25	3.70	3.31	high	0.33	9.97
	Learner development activities	40	3.34	4.00	3.81	very high	0.19	4.99
	Staff development	40	3.34	4.00	3.90	very high	0.16	4.10
	Network expansion	40	2.32	4.00	3.56	very high	0.43	12.08
	Average total	**40**	**3.07**	**3.91**	**3.68**	**very high**	**0.21**	**5.71**
Others	School Management	33	2.82	3.99	3.58	very high	0.30	8.38
	Curriculum	33	2.14	5.58	2.97	high	0.66	22.22
	Learner development activities	33	2.67	4.00	3.61	very high	0.35	9.70

Type	Practice	N	Min	Max	Mean	Level	SD	C.V.
	Staff development	33	2.82	4.00	3.77	very high	0.29	7.69
	Network expansion	33	1.58	4.00	3.13	high	0.63	20.13
	Average total	**33**	**2.45**	**4.14**	**3.41**	**high**	**0.39**	**11.44**

3.3.3 Outcome correlation

Table 2 shows the relationships of school practice variables and each element of outcomes. The curriculum and learner development activity factors can together explained 53.5% of the variance of difference of O-NET scores in 2011 & 2014 of grade 12 students. The curriculum factor can predict 21.33% of the variance of O-NET scores for grade 9 students.

The staff development and curriculum factors can together explained 14.1% of the variance of desired character level of grade 12 students. The staff development factor predicts 11.9% of the variance of key competency level of grade 12 students.

The school management and network expansion factors can collectively explained 26.2% of the variance of community satisfaction.

Table 2. Correlation between Sufficiency-based school practices and outcomes

Outcome variables		Stepwise				
		Antecedents	R	R^2	F	Sig
1 Student outcomes: **1.1 Difference of O-NET score in 2011 & 2014**						
	Grade 9	Curriculum	0.462	0.213	8.671*	0.006
	Grade 12	Curriculum	0.542	0.294	7.483*	0.140
		Learner development activity	0.731	0.535	9.771*	0.001
1.2 Key competencies						
	Grade 6	Learner development activity	0.250	0.062	5.988*	0.016
	Grade 9	Network expansion	0.228	0.052	5.103*	0.026
	Grade 12	Staff development	0.345	0.119	7.985*	0.006
1.3 Characters						

Outcome variables		Stepwise				
		Antecedents	**R**	**R^2**	**F**	**Sig**
	Grade 6	Learner development activity	0.301	0.090	8.939*	0.004
	Grade 9	Network expansion	0.300	0.090	9.201*	0.003
	Grade 12	Staff development	0.375	0.141	9.651*	0.003
		Curriculum	0.444	0.194	7.136*	0.002
2. Changes to school personnel		Curriculum	0.237	0.056	8.546*	0.004
3. Changes to community						
3.1 Changes to community members		Learner development activity	0.311	0.097	15.325*	0.000
3.2 Community satisfaction		Network expansion	0.474	0.224	41.366*	0.000
		School management	0.512	0.262	25.239*	0.000

In addition, *learner development activity* has predictive power over key competencies and desired characters of grade 6 students, and changes to community members. The *network expansion* is found related to key competencies and desired characters of grade 9 students and community satisfaction.

4. Discussion

Findings from the first phase revealed five key SELC practices: readiness preparation and school management of sufficiency learning; sufficiency based curriculum and learning system; wide-ranging school activities; encouraging sufficiency habits in individuals and the community; and sufficiency-based program expansion to other schools and communities. Furthermore, the key success factors of SELCs include: faith in sufficiency principles, shared personal characters based on SEP, professional development of staff; expertise in education for sustainability; a curriculum committed to sustainability; an enabling environment, effective multi-stakeholder partnerships; and focusing on socio-cultural-environmental dimensions of sustainability.

The finding here of the sufficiency-based school focus on socio-cultural dimensions of sustainability rather than being restricted to “green” agendas confirms the findings from a study of sustainable schools in New Zealand, Sweden and China (Henderson and Tilbury, 2004) and a report from a governmental sustainable school framework in Britain (Scott, 2009). The Thai findings here also accord the success factors identified by Henderson and Tilbury (2004) such as expertise in education for sustainability; professional staff development; curricula committed to sustainability; effective multi-stakeholder partnerships; and political support.

Furthermore, many key features of findings in the first phase are in line with the findings of the Report on the UN Decade of Education for Sustainable Development (Wals, 2012), a report from an international study (Henderson and Tilbury, 2004) and a report in Britain (Scott, 2009). They identify visionary leadership, social networking, new forms of inquiry, and high levels of participation as key elements in sustainable school approaches. School leaders need to encourage involvement and consensual decision-making. Similarly, the UN reported that sustainable education requires more integrative, problem-based and exploratory forms of learning that invite participants to be critical, creative and change-oriented. The school can be a "learning organisation" using participatory learning approaches for students, reflective practice for teachers and providing regular professional development for all participants. Furthermore, sustainable schools require whole-of-school approaches, synchronising learning with school operations and emphasise the active engagement of multiple actors in the joint redesign of basic operations.

The second phase results provide strong evidences in terms of the higher level of key competencies and desired characters of sufficiency-based school students and community satisfaction, when comparing to other schools. This finding from Thailand supports a result from a review of international sustainable school programs (Henderson and Tilbury, 2004) that found whole-school approaches to sustainability to have an important contribution to make in shifting the communities towards sustainability. The finding on the overview of academic O-NET result of Thai sufficiency-based school students provide a fair evidence of higher results than other school students. However, the evidence is not as strong as the other three outcomes (student competencies, student characters and community satisfaction).

In terms of school practices, there is a clear evidence of higher extent of the five practice dimensions in sufficency-based schools than other schools. Other schools received very high scores in only three dimensions, excepting two dimensions of curriculum and networking to expand results. Regarding these two dimensions, the study also found that *curriculum* variable, together with learner activity development, predicted 53.5% of the variance of O-NET scores of grade 12 students. The curriculum factor alone can predict 21.33% of the variance of O-NET scores for grade 9 students. In addition, curriculum, together with the staff development factor, can explained 14.1% of the variance of desired character level of grade 12 students. The *network expansion* is found related to key competencies and desired characters of grade 9 students. Together with the school management variable, network expansion can explained 26.2% of the variance of community satisfaction. Therefore, if other schools can improve in terms of curriculum and network expansion, this should positively impact their outcomes.

5. Conclusions

This paper describes the growing sufficiency movement and provides evidence-based outcomes in Thai schools. Some aspects are unique to Thailand, but the general concept can be applied elsewhere. SEP-based education is intended to help students to understand and practice SEP in their daily lives, helping them to be self-reliant, good citizens, live a balanced life, and be resilient. Teachers and students learn and practise SEP together, by participating in a variety of activities and learning-by-doing.

The SEP movement in education starts with a sufficiency curriculum and set of activities, but requires a whole-of-school approach to be effective. Under a whole-school approach, sufficiency is embedded in all school operations, including in administration and the physical environment so that students perceive sufficiency as "normal". Certification of sufficiency schools is a novel intervention to strengthen the progress of sustainability in Thai education. Schools apply to be recognised as sufficiency-based, and many are mentored by accredited SELCs schools.

Clearly, the SEP school outcomes are key competencies and desired characters of students, as well as community satisfaction. The academic results of SEP schools were better than other schools in general, but still had fluctuation among different types of SEP schools and among three different years examined.

Challenges for the future of the sufficiency movement in Thai schools abound. They include the ability to sustain a sufficiency culture in the certified sufficiency schools, attract and integrate new schools into the sufficiency movement and involve other larger society actors in the movement, especially the media. Three key challenges are discussed below.

Firstly, maintaining sufficiency practices in schools is impacted by the fact that Ministry of Education policy enforces the rotation of school heads every four years across schools. Incoming headmasters often choose to implement new initiatives rather than continue the sufficiency approach, and as a consequence there is more risk whether the sufficiency movement in each school will continue.

Secondly, there are challenges in persuading other schools to join the sufficiency movement. Existing sufficiency schools are normal, small schools that got involved not because of the ministerial policy or the media, but because of their inside-out desire for change, coupled with hearing about effective outcomes spread by word-of-mouth from pioneer sufficiency schools. Resistance from teachers is a major issue, but their support is essential for increasing the sufficiency-based school number.

Thirdly, even though we cultivate a SEP mindset in students and their local communities, when students finish school and enter the wider society such as moving to other communities or provinces, their new surroundings might not be compatible with SEP thinking. Therefore, it might be difficult for them to sustain their SEP mindset and practices. A decade of political turmoil has slowed the development of sustainability in Thailand, which requires participation from many sectors of the society in addition to education. SEP participation is also needed from the media, which are generally not in accord with sufficiency practice in their own operations.

In terms of spreading SEP across countries, SEP shares many similarities with the main concepts of other international EfSD approaches, including focusing on balanced development between physical, environmental and social matters. SEP is also in line with international character building methods such as learning-by-doing, learning through reflection, self-discovery (rather than memorisation), and developing 21st century skills. Developing SEP-oriented attitudes and practices in schools and communities clearly supports the UNESCO vision of “Education for Sustainable Development.” (UNESCO, 2007).

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Advancing a Core Indicator Framework for Sustainability Reporting in Higher Education Based on the GRI's Materiality Principle

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Abstract

Sustainability reporting, a mostly business-oriented practice, is a potential tool for higher education institutions (HEIs) to monitor, assess and communicate sustainability performance to their stakeholders. Sustainability reports from the higher education sector have increased from one report in 2004 to 60 reports in 2014, according to the Global Reporting Initiative's (GRI) Disclosure Database (GRI, 2016); yet no large diffusion of the practice is expected for the coming years (Alonso-Almeida et al., 2015). One of the reasons for this slow adoption may be the fact that there is still no comprehensive set of indicators available, specifically for the higher education sector, to use within a reporting framework (Ceulemans et al., 2015a). The main indicators lacking in sustainability reports of HEIs comprise those to measure higher education's core activities of education, research and community outreach (Fonseca et al., 2011; Lozano, 2006, 2011; White and Koester, 2012; Yarime and Tanaka, 2012). While in 2006, Lozano presented a preliminary set of core activity indicators in addition to the indicators present in the GRI Sustainability Guidelines; no major further advances have been made on this topic and the validity of this indicator set has not been tested through empirical research (Ceulemans et al., 2015a). Ceulemans et al. (2015a) also suggested the need for further research on the topic of indicator development for sustainability reporting in higher education. Recent research on sustainability reporting in higher education has pointed out that HEIs are 'pointing at power' regarding this topic, i.e. they are expecting external parties or stakeholders to develop such indicators for them (Ceulemans et al., 2015b). However, as the final aim of such indicators is to create change towards sustainability in higher education (Ramos and Pires, 2013), it is important for HEIs to indicate which types of indicators offer them the largest potential for change in the sustainability integration process. Hence, their involvement in the development process of such a core indicator set is crucial. Looking at the recent developments in the GRI Sustainability Guidelines, the GRI G4 guidelines may offer interesting pathways to further address this topic. In the GRI G4, a larger importance is set on the principle of 'materiality', i.e. the inclusion of information on topics that are material to the organisation and its stakeholders. Adhering to the GRI G4 guidelines thus implies that the content reported on in such reports includes information on HEI's core activities, an issue that has been previously missing. Therefore, this study focuses on the HEIs around the world that have published sustainability reports through adherence to the GRI G4 guidelines. The research comprises of a document analysis of a total of 21 reports from 2013-2015 (as the GRI G4 guidelines have been published in May 2013), of which the main results will be presented during the conference. The research was performed through qualitative content analysis, based on the indicator framework presented in Ceulemans et al.'s (2015a) review on sustainability reporting in higher education, and augmented with additional indicators present in the most widely used assessment tools for sustainability in higher education. The main aims of the study are the following: (1) identifying which core indicators and themes HEIs are reporting on in sustainability reports when adhering to the GRI G4 guidelines; and (2) developing an advanced core indicator framework for sustainability reporting in higher education, based on previous research and GRI's materiality principle. Additionally, some recommendations for practitioners in the field will be expected, aimed at how to improve the practice of sustainability reporting in higher education through the application of the materiality

principle.

Keywords: Sustainability reporting, higher education, sustainability indicators, materiality, Global Reporting Initiative

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Business Ethics and Corporate Social Responsibility Teaching in Management Study Programmes

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Abstract

Among the challenges created by a false sense of prosperity, one of the most urgent remains the establishment of a systemic approach to solving the macro-problems that impede Sustainable Development. This requires the concerted effort of all political, social and economic agents, including those who are responsible for a mind-set change, which includes Higher Education. Within the UN Decade of Education for Sustainable Development and considering the Principles for Responsible Management Education, it becomes clear the need for an integrated reorientation of management study programmes, to a realistic paradigm which contemplates sustainability as a core value. Its expression in business management is essentially based on two broad concepts: Business Ethics and Corporate Social Responsibility. These are usually the vehicles through which the issue of sustainability is introduced in management curricula. We analysed the whole population of 55 self-assessment reports from Portuguese undergraduate management programmes, which Higher Education Institutions are required to complete when requiring a program's accreditation, as well as its websites. With this, we collected the institution's discourse about intentions and hopes, which in many cases could have been understandably self-praising, on their management programmes. We investigated how integrated the concepts Business Ethics, Corporate Social Responsibility and Sustainable Development are, in the programmes curriculum. We also researched about the faculty teaching them and the general significance assigned by the Higher Education Institutions to these topics. Using a content analysis methodology in a mixed methods approach we found trends in the way these subjects are being taught, as well as the use of different tools and teaching methodologies. We conclude the integration of management curricula around Business Ethics, Corporate Social Responsibility and Sustainable Development is virtually non-existent in Portuguese Higher Education, although a significant part of these courses have a discipline dedicated to these issues. We demonstrate the differences, especially between educational subsystems in the way these same disciplines integrate these issues and trends in its faculty's areas of training. We found the general absence of an experiential approach to teaching of these subjects, through the valuation attributed to the practical component and the kind of teaching tools chosen to teach them. This paper's main contribution is the conclusion that global commitments in the field of management teaching in Higher Education continue to lack a practical effect in Portugal, specifically those concerning the need for a new organizational paradigm.

Keywords: Higher Education, Education for Sustainable Development, Corporate Social Responsibility, Business Ethics, Management

1. Introduction

In the context of Sustainable Development (SD) it's to universities that societies delegate a large part of the responsibility for informing their management, in the form of governance, of the problem of choosing between to survive or languish (Gough & Scott, 2008, p.166). The early summon of Higher Education to this emergence, soon led to several commitments on the part of the Academia. Preceded by the Brundtland Report (WCED, 1987) the Declaration of Talloires is the oldest convention in Higher Education (HE) related to issues of sustainability and social responsibility. Its signing is still seen as a strong signal of the institution's desire to commit to SD (Adlong, 2013; Beringer, Wright, & Malone, 2008; Wright, 2010). Nevertheless, only one of the 499 signatory Higher Education Institutions (HEI) is Portuguese. Later and as a result of the UN Global Compact (United Nations, 2000) it was understood that the necessary change in the behaviour of companies, in order to become more responsible and sustainable, should involve the main institutions that most directly act as drivers of corporate behaviour, especially Higher Education ones (United Nations, 2007, p. 3). United Nations invited the leading universities and business schools to then endorse a set of principles, the Principles for Responsible Management Education (United Nations, 2007, p. 4). The guiding principles of the Convention imply the development of the capabilities of students to be future generators of sustainable value for business and society, the incorporation into academic activities and curricula of the values of global social responsibility and the creation of educational frameworks, materials, processes and environments that enable effective learning experiences for responsible leadership.

Between these initiatives others, in the same spectrum, took place. These include: the “Creating a Common Future: An Action Plan for Universities” document, an outcome of the Halifax Conference (Lester Pearson Institute for International Development, 1991); the Declaration of Swansea (Association of Commonwealth Universities, 1993); the University Charter for Sustainable Development of the European Council of Rectors (COPERNICUS, 1993); the Declaration of Kyoto of IAU (International Association of Universities, 1993) and the President's Climate Commitment ACU (American College & University, 2000). With all these initiatives, it is clear the desire to see HE as a guarantor of literacy and education in sustainability and social responsibility. Thus not being possible that HEIs and their governance ignore the challenge, and they aren’t, since HEI accept responsibility for leading society towards a sustainable future (Cortese, 2003). Universities have the expertise necessary to develop the intellectual and conceptual framework to increase the awareness, knowledge, technologies, and tools to create an environmentally sustainable future, and must play a strong role in education, research, policy development, information exchange, and community outreach (Cortese, 1992). Still, the signature of these conventions, does not guarantee increased social performance of the institutions which subscribe them (Beringer et al., 2008). They may influence the inclusion of these ideas in the study programme’s curricula as guidelines, but only to a certain extent, since it will always depend on the faculty’s will and ability to educate for SD.

Education is one of the key factors in building essential human capacities in the process of SD, such as consciousness, knowledge and skills (Jansen, 2003). Education for Sustainable Development (ESD) is a vision of education that seeks to balance human and economic well-being with cultural traditions and respect for the earth’s natural resources (Unesco, 2002). Learning can be formal or informal, and as Blewitt (2015, p.311) puts it, we can learn through good communication and communicate through learning and both need to resonate with the transformative practices that affect both self and others. University teaching educates people that will shape the future society and be influential decision-makers on all fields and levels (Svanström, Lozano-García & Rowe, 2008). It also informs future citizenship behaviour to students, by design or by default. Academic research has impacts on a wider context within which lives are lived, citizenship practised and further learning achieved (Gough & Scott, 2008, p.168). ESD aims at enabling people to not only acquire and generate knowledge, but also to reflect on further effects and the complexity of behaviour and decisions in a future-oriented and global perspective of responsibility (Barth et al., 2007).

Transformative education prepares students capable of addressing complex sustainability challenges, which requires it to be more interactive and focused on the learner (Ferrer-Balas, 2008). Universities are approaching the transformative needs of ESD in many perspectives. Among most common approaches, are the campus “greening”, development of special courses on sustainability, or offering collaborative research opportunities (Ferrer-Balas, 2008). Nevertheless, a common set of learning outcomes seems to emerge. It includes systemic thinking, interpersonal and intrapersonal skills development and a strong emphasis on change agent skills (Svanström, Lozano-García & Rowe, 2008). It is well established in research, that curriculum change, namely in expected learning outcomes and syllabus of a study programme is fundamental for this transformative change (Cortese, 2003, Downs & Golovko, 2016, p.78; Gruszka & Rammel, 2016, p.184; Harpe & Thomas, 2009; Iyer-Raniga et al., 2016, p.164-165; Kagawa, 2007; Lozano, 2010; Wiek, Withycombe & Redman, 2011). Education at universities has a decisive role in training future business leaders with skills that are needed in the turbulence of the changing requirements concerning social responsibility issues (Pesonen, 2003).

Decision making is made all the more complex by a number of technical, economic, environmental, social and ethical constraints. In particular, environmental sustainability has given rise to a new framework of context analysis (El-Zein, 2007). Managers are professional decision-makers, so it is crucial for their integration in this project, to develop their ethical decision making skills as well as their sensibility towards Corporate Social Responsibility (CSR). The way universities have found, particularly in their management study programmes, to encourage a more robust and informed process of ethical decision was incorporating SD concepts, goals and systemic view into their curricula, in particular, CSR and Business Ethics (BE) materials, theoretical and practical. Despite that integration, many students have difficulties developing these capabilities especially during the short time that a degree in management lasts (Brumagim & Cann, 2012). One reason for this difficulty is that the management programme isn't usually wholly integrated (Markulis, Howe, & Strang, 2005) around unique and unifying concepts. A unique formula does not exist to achieve this integration and a variety of approaches and methods can be used in this process (Athavale et al, 2008; Rusinko, 2010). However, there is consensus among the leaders of educational institutions that this integration of the management curricula around ESD is required. Constituting a critical success factor for the professional lives of students (Athavale et al, 2008; Pesonen, 2003), this integrated approach also allows them to understand the interdependence of the different functional areas of an organization (Athavale et al., 2008), its complexity and the accountability of its actions. In this paper we study the level of integration of Business Ethics, Corporate Social Responsibility and Sustainable Development in Portuguese undergraduate management study programmes. Which might shed a light upon the real efforts Portuguese HEIs are making to comply with global conventions in the field of ESD.

2. Methods

The fifty-five Portuguese undergraduate management programmes in operation were analysed using a content analysis on their mandatory self-assessment reports, based on fixed guidelines and intended for accreditation by the Portuguese Agency for Assessment and Accreditation of Higher Education (A3ES). The examination of these reports was done using two dimensions of clusters: subsystem and type of property as shown on Table 24. Similar to other author's methodology (Matten & Moon, 2004; Christensen et al, 2007), the analysis focused on the programme's curricula, structure, syllabus, expected learning outcomes and faculty.

Table 24- Undergraduate management study programmes in Portugal, by subsystem

	Private	Public	Total
Universitary	20	16	36
Polytechnic	6	13	19
Total	26	29	55

The reports were analysed using MaxQDA™ software, through which were extracted and coded 1606 text segments. After a critical analysis of this segments, the existence and development of topics as CSR, BE and SD was quantified using descriptive statistics methods. When relevant, a Likert scale of five points was used to categorize the development degree with which each topic was addressed in the learning objectives, syllabus and bibliography of courses. Two types of course were identified in the curriculum: dedicated courses, which only contain these topics and non-exclusive courses, which being from another subject, still make some references to CSR, BE or SD. Websites of each course of the study programme and the programme itself, when available, were also mined for any information that might be relevant to our research. This content analysis is then limited to information available on the websites and self-assessment reports.

Given the uniformity of the reports used in the accreditation of study programmes, this information is invariably divided into: objectives and detailed curriculum of the course, learning objectives, syllabus, bibliography and faculty records such as scientific field of their degree, research field and publications. The coded information for each of these variables is often not explicitly written in the self-assessment reports and sometimes result from the interpretation of the speech. However, the possibility that this discourse is aligned with sustainability values isn't necessarily a confirmation by itself that the objectives and issues are pursued and addressed respectively. It is therefore ideally a guiding intention that might later inspire the operationalization of the course, without its effectiveness being confirmed. The hypothetical existence of a pro-sustainability and CSR discourse could still be, at worst, only a sterile communication strategy of the institutions.

3. Results

The frequency with which the subjects studied here were found in the objectives of the different undergraduate programmes, can be seen in Table 25. Only about one-third of these programmes (36%) have general objectives described in the context of Business Ethics. This reference is often made in the self-assessment reports by statements that refer to the student's integrity as an individual and to a less extent, to his professional moral duties.

Table 25 - Subjects covered in the undergraduate program's objectives

Subject	Programmes with objectives related to the subject	% of the total programmes (n=55)
Business Ethics	20	36%
Corporate Social Responsibility	17	31%
Sustainability / Sustainable Development	5	9%

There are references to CSR related objectives in some (31%) study programmes. This issue is addressed frequently in one of two ways. In some cases, it is mentioned as part of the HEI's strategic guidelines which is offering the program and not exactly of the programme itself. In other cases, it refers to practical aspects of CSR referring volunteer extra-curricular programs where teachers and students participate and are usually linked to the development of the region where the HEI belongs. Virtually none of this evidence seems to be under the umbrella of sustainability. Only five of the study programmes analysed have a brief reference to the framing of these issues in the Sustainable Development paradigm. A query to the websites of Higher Education institutions, including the webpages for each course, confirms this light approach to the issues. In most (73%) of the fifty-five programmes analysed there is no reference to BE and CSR. In only a minority of these electronic pages can one find goals or statements of intentions towards CSR. Of the fifteen study programmes which have some reference to BE or CSR, nine mention ethical issues in their presentation; eight mention objectives associated with CSR and only two refer to SD. In the latter case, one of these two institutions, it is stated that the study programme is designed to foster a solid and diverse training, focused on the modern management of companies and organizations, according to the paradigm of Sustainable Development. In another institution, the statement is relatively vague, standing by the commitment to students to develop problem-solving skills in commitment to Sustainability. From the content analysis results the evidence that the matters of BE, CSR and SD are even less mentioned in the learning objectives of the programme than in the programme objectives itself.

Only thirteen study programmes (24% of total) have a learning goal related to these matters. The context in which these matters are referred to, are the same as presented in the study programme general objectives. The issue of Ethics is addressed both in the individual and professional dimensions of the student, as an individual and as a future manager. In what concerns the skills that few studies programmes intend to develop in the CSR scope, most of them are related to the student's skills to identify and develop CSR-like experiences or understand it's most relevant problems. The absence of any reference to Sustainable Development in the learning objectives of the study programmes shows that, in addition to only a minority of institutions recognizing that BE and CSR are important concepts in an undergraduate degree in management, they also ignore those subject's contextualization in a SD paradigm. The operationalization of these goals is often made by including a dedicated course of BE and/or CSR in the curricula. It should be noted that all study programmes analysed show at least some evidence of BE and CSR teaching. However, only a part of them (58%) possess a course which exclusively addresses these subjects. Table 26 shows the distribution of these dedicated courses by subsystem.

Table 26 - Dedicated BE&CSR courses by subsystem

Programmes	Private		Public		Total
	N	%	n	%	
University	14	70%	6	40%	20
Polytechnic	2	33%	10	71%	12
Total	16		16		32

It follows from this analysis that Private Polytechnic programmes have the lowest prevalence of dedicated courses. Similarly, it can be observed that dedicated courses are more frequent in the Private Universitary subsystem, since fourteen (70%) of these programmes have them. Their nomenclature has, almost invariably, the terms "Ethics" and / or "Social Responsibility" (see Table 27).

Table 27 - Nomenclature of the dedicated BE&CSR courses

Course name	Frequency	%
Ethics or Business Ethics	17	53%
Business Ethics and Corporate Social Responsibility	12	38%
Other nomenclatures	3	9%

This naming is similar to that observed in other European countries (Matten & Moon, 2004). The three courses that do not use these buzzwords, use synonyms to designate them, like "Economic and Corporate Responsibility", "Professional Ethics and Ethics" and "Humanity and the Future: Ecological, Ethical and Poietical Paradigms and Human Rights".

We sought to find speeches about the different approaches to Business Ethics in dedicated courses of BE and CSR. Evidence of two different types of approach was therefore found: one devoted to the philosophical foundations of Ethics, which we'll call Ethical Philosophy; and other more dedicated to the operationalization of ethical values and codes, henceforward referred to as Applied Ethics. A summary of the evidence of each of these approaches can be found in Table 28.

Table 28 - Different Approaches to Ethics in BE&CSR dedicated courses

Subject	Objectives	Syllabus	Bibliography
Ethical Philosophy	15	24	15
Applied Ethics	22	29	28
Both Approaches [1]	10	23	15
Courses where Ethics is taught [2]	27	30	28
Proportion [1]/[2]	37,0%	76,7%	60,0%

Evidences of Business Ethics presence in the study programmes were thereafter classified in a Likert scale, regarding the level of detail in those references. Through the analysis of the text segments extracted from the reports, it was possible to classify the approach to Ethics in each dedicated course in a five point scale, between: 1 – Not mentioned and 5 – Course dedicated to this subject. Results were then summarized in Table 29.

Table 29 - Level of detail in the approach to Ethics in BE&CSR dedicated courses

	Polytechnic				Unversitary				Total	
	Private		Public		Private		Public			
	N	%	n	%	n	%	n	%	n	%
Total Study Programmes	6		15		20		14		55	
Programmes with a dedicated course	2		10		14		6		32	
1 - Subject not mentioned			1	10%					1	3%
2 - Basic Concepts	1	50%	3	30%					4	13%
3 - Main concepts and theories			1	10%	2	14%	1	17%	4	13%
4 - Concepts, theory and applications	1	50%	4	40%	11	79%	5	83%	21	66%
5 - Course dedicated to the subject				0%	1	7%			1	3%
n/i - not identified			1	10%					1	3%

In the course's objectives, there seems to be a greater concern with the way Ethics is applied than with its philosophical foundations. Among the twenty-seven dedicated courses which have specific objectives in the field of Ethics (see Table 28), the most common approach is to mention issues such as the ability to make ethical decisions, ethical issues in professional practice or the ethical implications of a business activity. Fewer are the courses with specific objectives related to Ethical Philosophy. Only ten of these subjects (see Table 28) mentioned goals which included both approaches. It is assumed that teaching in these cases has aimed at providing theoretical foundations to students that they can later test in concrete professional situations, as classwork. These ten programmes are all from the Universitary subsystem and the majority of those belongs to the Private sector.

Almost all dedicated courses frame their expected learning outcomes in the student's ability to recognize moral issues, conflicts and responsibilities. In the Polytechnic subsystem this is the only objective mentioned. While in the case of more than half of the Universitary study programmes, dedicated courses enunciate a concern with the student's ability to recognize specific moral aspects of a given situation. In some other Universitary programmes their dedicated course presents a concern with the development of skills related to the dealing with and decide upon moral dilemmas, especially in the management context. The trend of non-intersection between the two approaches to Ethics education in the specific learning objectives of the course does not arise in its syllabus examination. Among the twenty-four studies programmes which address Ethical Philosophy issues in their syllabus and the twenty-nine which state a more practical approach to the subject, twenty-three of them match (see Table 28). It is therefore a relevant result of this work, that the vast majority of undergraduate programmes which address matters of Ethics in a dedicated course thoroughly cover the subject. The Ethical Philosophy content deals, mostly, with the different ethical theories. However, content on meta-ethical issues is also quite frequent in the syllabus, as well as adjacent philosophical concepts.

Table 30 - CSR in dedicated courses, by subsystem

Dedicated BE&CSR courses by HE subsystem		Course						Total	
		Objectives		Syllabus		Literature			
		n	cluster %	n	cluster %	N	cluster %	n	cluster %
Private	Universitary	5	36%	12	86%	6	43%	13	93%
	Polytechnic	0	0%	1	50%	1	50%	1	50%
Public	Universitary	5	83%	4	67%	5	83%	6	100%
	Polytechnic	1	10%	5	50%	6	60%	6	60%
Dedicated courses referring CSR (total)		11	34%	22	69%	18	56%	26	81%
Universitary subsystem		10	50%	16	80%	11	55%	19	95%
Polytechnic subsystem		1	8%	6	50%	7	58%	7	58%

Again, it is observed the same trend from Private Universities, which have a more comprehensive approach to the issue of Ethics. Of the twenty-three courses which have contents on both approaches (Table 4), eleven are privately owned Universities, eleven are from Public HEI and only one is a privately owned Polytechnic HEI. All courses which have dedicated literature in the field of Ethical Philosophy, also have literature in the field of Applied Ethics. These courses, which have thus a more robust literature, able to answer the theoretical and practical challenges of this area of study, are mostly of Universitary HEI's (10 in 14).

Of these, seven belong to private Higher Education college, confirming the trend detected in the objectives and content of the exclusive subjects of this subsystem, to address more fully the issue of Business Ethics. From the study programmes analysed, twenty-six of them have a dedicated course where issues within the CSR scope are address (Table 7). Similar to the Business Ethics education, it's the Private Universitary subsystem which shows further evidence of teaching these subjects. Thirteen of the twenty-six courses which have a unique discipline belong to this subsystem. This presence is especially felt at the syllabus level, where eighty percent of Universitary study programmes have CSR related content. Despite this significant presence of the subject, only thirty-four percent of dedicated courses have CSR related objectives. In what concerns the level of detail of CSR integration is made by subsystem, similar to what was done to the case of BE, we present in Table 31 a summary of the evidence of the content analysis using a five-point Likert scale. Again, the segments coded as relating to CSR, were analysed for the intensity with which addressed, graduating them in a Likert scale of five points.

Table 31 - Level of detail in the approach to CSR in BE&CSR dedicated courses

	Polytechnic				Unversitary				Total	
	Private		Public		Private		Public			
	n	%	n	%	n	%	n	%	n	%
Total Study Programmes	6		15		20		14		55	
Study Programmes with dedic. course	2		10		14		6		32	
1 - Subject not mentioned	1	50%	3	30%	1	7%			5	16%
2 - Basic Concepts			5	50%	6	43%	1	17%	12	38%
3 - Main concepts and theories					6	43%	2	33%	8	25%
4 - Concepts, theory and applications	1	50%	1	10%	1	7%	3	50%	6	19%
5 - Course dedicated to the subject										
n/i - not identified			1	10%					1	3%

Using as reference the list of CSR theories elaborated by Garriga e Melé (2004) we were able to categorize the different approaches to the subject. The results which are summarized in Table 32 were not directly expressed in the self-evaluating reports, but instead derive from an interpretation of the coded segments extracted from them in the content analysis. There are significant differences between the approach to CSR in the polytechnic and university subsystems. In polytechnic education, the approach is usually integrative, which in this context means that it is through the satisfaction of social needs that the company receives prestige and legitimacy to operate. This integrated view values the discussion of pressing issues in society, between stakeholders and organization. It assumes that it's through feedback to the concerns of the most prominent stakeholders that the company gets the legitimacy which allows it to operate in the community. In the Universitary subsystem predominates an ethical vision of CSR. It means, therefore, that in Universitary courses it's more common to find a concept of CSR based on the need of companies to act in the right way in order to contribute to the common good. This ethical approach is compatible with the more comprehensive teaching of Ethics already found in the Universitary subsystem. The course objectives related to CSR, in the eleven courses (see Table 7) which have them, are very homogeneous. In general, the concept of stakeholder is introduced and it's referred the importance of the manager's sensibility to recognize issues that may be connected to corporate social responsibility. The CSR concepts often appear together with ethical ones. In general, one can say that these dedicated courses have no major concern with the establishment of learning objectives related to CSR.

Table 32 - Different approaches to CSR in dedicated courses of BE/CSR

Approach / perspective	Polytechnic		Universitary		Total
	Private	Public	Private	Public	
Instrumental	0	0	1	0	1
Political	0	0	0	1	1

Integrative	0	5	3	3	11
Ethical	1	1	9	1	12
Unidentifiable	0	0	0	1	1
Total of courses	1	6	13	6	26

The content analysis revealed that only 34% of these do it, to some degree. It should also be noted that a difference between the Universitary and Polytechnic subsystems exists, in this matter, with a clear advantage for Universitary HEI. Although it's not frequent the establishment of goals related to CSR, a large part of the BE and CSR dedicated courses feature content related to these materials in their syllabus. It turns out, however, that in seventeen of these twenty two courses (77%) the CSR-related content in the syllabus boils down to the basic concepts or at best presenting a description of CSR theories and some of the concepts associated with them. Here too, the contents refer to specific codes or regulations used by companies to deal explicitly with social issues.

Among the eighteen dedicated courses referring literature linked to CSR (see Table 30), one can identify some patterns. First, the found literature is mostly Portuguese, with special focus on four works that are repeated in various courses. The selected works cover very satisfactorily the field of CSR and is only noticed the absence of most foreign authors of the recommended bibliography. With regard to the issue of SD, it was observed that the subject is absent from virtually all dedicated courses. Although one can find references to SD, it never appears as a foundational problem, but rather as one more reason for the need to teach Ethics and Social Responsibility in business management. This generic reference without any context to SD and Sustainability as the same, casts doubt on the meaning given to the terms and about the study programme really containing some sort of approach to the issue. Only five of the programmes with dedicated courses, address issues of Sustainability or SD in its syllabus. References to the theme are divided between generic content on SD while other courses just a focus on the ecological dimension of it. In one case, which falls into this second approach, the concept of SD is disassociated from its economic and social aspects, being referred to as "planet's sustainability" The specific literature on SD is insignificant. The academic background of the faculty who teaches these subjects are divided into two major scientific fields: humanities, including philosophy and business sciences (Table 33). Nineteen of these faculty members have their main degree in business science (management, accounting, economics, etc.), while the remaining eleven have a humanities or social sciences degree (sociology, education, philosophy, etc.).

Table 33 - Academic Background of the faculty teaching BE & CSR

Scientific Field	Main degree (usually PhD)	Secundary degrees
Management	10	5
Philosophy	8	2
Economy	6	1
Accountancy	2	0
Social Science	1	0
Education	1	2
Auditing	1	1

Sociology	1	1
Human Resources	0	3
Psychology	0	1
Antropology	0	2
Business Sciences	0	1
Systems Engineering	0	1
Ethics	0	1
Literature	0	1
Total	30	22

One should note that eight of these teachers have their main degree in philosophy, and there is one more member of faculty with a secondary degree in this area. From the seven faculty members with the highest number of publications in the field of BE / CSR / SD, four of them have a degree in philosophy.

Table 34 - Faculty's scientific publications

Scientific field	Faculty	Publications	Pub. per teacher
Business Science	19	26	1,4
Philosophy	8	17	2,1
Social Science	3	2	0,7
Total	30	45	1,5

From the 45 publications related to these themes presented in faculty's curriculum (each report gathers the five most important publications), seventeen are authored by faculty with a degree in philosophy (see One should note that eight of these teachers have their main degree in philosophy, and there is one more member of faculty with a secondary degree in this area. From the seven faculty members with the highest number of publications in the field of BE / CSR / SD, four of them have a degree in philosophy.

Table 34). Publishing ratio on these matters is greater among faculty with a degree in philosophy whom all teach in the Universitary subsystem.

4. Discussion

Considering the possibility of the HEI's discourse, about the objectives of their undergraduate management study programmes, often having the laudatory purpose of promoting a responsible, competent and modern institutional image, like other organizations do (Vilar, 2012, p. 41) one would expect that the concepts of Business Ethics, Corporate Social Responsibility and Sustainable Development, would now be a recurring presence in these reports, in particular in its learning and general goals. Mostly because the documents analysed are essentially speech, and such a degree of freedom and creativity in their completion could easily lead to establishment of unattainable but also unaccountable goals. However, unlike what happens in some foreign undergraduate management study programmes (Christensen et al., 2007, Nicholls et al, 2013) these issues still haven't won sufficient relevance at least for now, in Portugal, to the point of being included as key points in an attempt to attract new students to the institution. There remain, therefore, beyond doubt, that expected learning objectives, in the context of ESD, are not present in undergraduate management courses because that is not the desire of HEI coordinators. What also suggests a non-supply of the needs set out by Persons (2012), and a lack of interest in strategic alignment with international conventions which represent the commitment of HEI to SD, such as the Declaration of Talloires (Adlong, 2013) and the Principles for Responsible Management Education (United Nations, 2007).

The possibility that skills in these areas are not attractive to the labour market might, therefore, explain why potential students wouldn't value them, when deciding to apply for a place in Higher Education. This would thus mean that the Portuguese labour market would be counter-cyclical to other countries, where the demand for students with these skills has increased (Cartland, 2010; Hesselbarth & Schaltegger, 2014; Matten & Moon, 2004). This possibility is reinforced by the high perception of corruption (Melgar et al, 2010), with diminished economic freedom (Heritage Foundation, 2014) one can observe in Portugal and which could lead to a certain detachment and depreciation of any company's public image and reputation, especially the most powerful ones. Less than sixty percent of the study cycles in management, mostly in Universitary HEIs, have a course dedicated to Business Ethics and Corporate Social Responsibility, which is considered one of the most common ways to include these subjects in the curricula (Bowden & Smythe, 2008; Matten & Moon 2004; Crane, 2004; Johnson et al., 2007, Nicholson & DeMoss, 2009).

The enrolment in these courses is almost always mandatory in Private HEIs. What, moreover, is consistent with the observation of Nicholson and DeMoss (2009) which had already noticed the greater appetite of Private HEIs for the inclusion of these matters in a more complete form in the curricula. Although mostly mandatory across the entire HE system, a trend already studied in Europe (Wu et al., 2010), these courses are mostly given an amount of ECTS's lower than the standard course in a management program. The reference, especially in Polytechnic programmes, to the professional orders of Certified Accountants and Auditors and the use of their code of ethics as literature in dedicated courses of BE and CSR, suggests a certain disregard with a new interdependent and accountable paradigm of the company, fostered by those same areas of knowledge. Most of Polytechnics can therefore teach Ethics in their management undergraduate courses, but one can almost be sure that they're not teaching Business Ethics framed on a Sustainable Development paradigm. Differences in the scientific fields of faculty's degrees confirm this idea.

Universities show a higher prevalence of philosophy academics, meeting the recommendations already made, Klein (1998). While Polytechnic HEIs tend to hire faculty in the management sciences, reinforcing the arguments of (Frederick, 1998; McDonald & Donleavy, 1995) about the philosopher's inability to deal with real and morally complex situations companies. This is consistent with a more focused Universitary education in ethical philosophy of the decision maker and a polytechnic education more focused on the personal ethics of the manager, consistent with the genesis of each of the subsystems. One notes a prescriptive tendency in the syllabus, towards an ethical single view, “avoiding” the student the trouble of making his own moral judgment.

Learning objectives established for these disciplines are in line with this conclusion. To a large extent, these show an intention that the learning obtained in these courses, capacitate students with the ability to identify moral dilemmas and, at best, help them understand the perspectives through which those problems can be addressed. But students in Higher Education are usually adults. They have therefore a complex code of values and don't need to get a new one. To deal with ethical dilemmas, like the ones Sustainable Development creates, Higher Education can thus "only" supply to students with what Gandz and Hayes call "ethical analysis tools that allow them to reconcile the responsibilities of their role as managers, with their moral responsibilities as social individuals" (Gandz & Hayes, 1988) and other authors such as Ronald Sims have defined as "moral reasoning" (Sims, 2002a; Sims & Brinkmann, 2003). However, the content analysis to the self-assessment reports, conveys the perception that the teaching / learning construct, in Portuguese undergraduate management study programmes, distance itself, in several steps, from this direction and from the set of core competencies which characterize an effective learning of

Business Ethics (Brinkmann & Sims, 2001; Sims, 2002b). One should note though, that in a few Universitary study programmes, there is already a concern to develop skills such as management of moral conflicts and the development of moral courage. This presents an image of undergraduate management study programmes, far from the idea of an integrated curricula around ESD, which is a loss in itself, because of the non-compliance with international conventions that should apply to Portuguese HEIs. But it's also a loss, because it withdraws the basis for an effective learning of Business Ethics and Corporate Social Responsibility.

All this happens while some international experiences begin to obtain positive results of this integration (Pesonen, 2003; Rusinko, 2010). For a management study programme to be aligned with ESD principles, one would have to find in its curricula evidences of a transformative action towards SD, grounded on BE and CSR. That is not the case of the analysed study programmes. The self-evaluation reports don't show a robust integration of the programmes around the interdependent and systemic view of SD, principles of BE or CSR dimensions and concepts. They also don't show any establishment of clear expected learning outcomes as the ones previously presented. One can then guarantee that the much needed transformative curriculum change fuelled by ESD, hasn't yet started to happen in Portuguese undergraduate management programmes.

5. Conclusions

The adoption of a new development paradigm requires radical changes in many quarters of modern societies, including Higher Education in general and management teaching in particular. Among these changes are the way one rationalize the exhaustion of some key natural resources for human existence, the exploitation of our and other species and the destruction of ecosystems homeostasis, all with huge impact on the current model of economy and business. But while many other sciences, especially the natural ones are helping to better understand how human activity has exacerbated these problems and trying to be part of their solution, economics merely recognize their responsibility in the development of skills, such as reshaping, modernize and internationalize companies, but rarely to change the paradigm of its operation. From what we have shown in this article, the few HEI that address the issues of BE and CSR in the study programme's objectives, say it in an instrumental way, with a speech that resembles corporate communication, disengaging these issues from their foundational ontological basis. In general, these undergraduate programmes show an alignment by a prospect of weak sustainability, establishing some general goals as to train managers desirably able to understand business complexity and be agents of change, but then technically training them to perform any management function within the current economic growth paradigm. We confirmed the idea that the degrees in management present Business Ethics and Corporate Social Responsibility as independent from the Sustainable Development paradigm, isolated in specific disciplines which appear to essentially serve to teach basic concepts and main theories.

This departmentalization of knowledge, contributes to an independent and competing view of the different challenges of SD. Experiential or interactive teaching methods are rarely described. The described teaching methodology is essentially expository and often limited to the presentation and analysis of codes of conduct. This evidence reinforces the idea that in Portugal, the Ethics which is present in management study programmes, serves more to limit the manager's action and ensure one's alignment with the organization's interests, and less to help one's autonomously reasons their organization's values and accountability to its stakeholders. The also noted decoupling of BE and CSR concepts from the SD construct, in established objectives and course curricula, is only compatible with an anthropocentric discourse which considers companies to be willing to contribute, on moral grounds, with ethical and responsible attitudes towards their stakeholders (especially the most salient) but not at any price.

It is never mentioned by HEIs an alignment by non-economic priorities, such as those required by an ecocentric paradigm. This feature together with the exclusively expository methods of teaching these subjects and with the little relevance, in ECTS terms, that these courses have in the whole management programme, seems to suggest that most HEIs wish to offer in their management degrees, the best of both worlds from the business point of view: on the one hand, comply with the supply of skills suited to create attractive soundbites in modern corporate communication, in the hope that these future managers will be proficient marketing agents; on the other, avoiding to overly discuss these issues, in extent and depth, in order to ensure that the whole programme curricula can be based on the same assumptions and is oriented to the education of economistic managers in the quest for the holy grail of financial efficiency, and not activists, since it is the first whom the labour market feeds on. This would explain why private HEIs seem to be more motivated to include these subjects in management study programmes.

Future managers don't need prescriptions for what is right, especially if they are, in fact, just guidelines to smoothly running gear-wheels. Instead, they need HEIs and their management study programmes to portray, in the first place, an accurate picture of the emergent corporate model: an interdependent, complex and accountable open system. Also, students need management programmes to be a safe environment where they can test and audit their codes of values and decision-making skills in order to openly discuss them and as a result, develop the necessary moral courage to deal with real world dilemmas. By not doing this, Portuguese HEIs are not complying with internationally agreed pacts upon an Education for Sustainability.

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Environmental Sustainability in Portuguese Middle and High Schools - Attitudes, Perceptions and Implementation

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Abstract

This study explores the perceived and implemented environmentally sustainable measures and the attitudes toward them in Portuguese middle and high-school educational institutions. This work was supported through data triangulation and the relevant pillars of this investigation were the analysis of an e-mailed questionnaire survey and the exploration of posterior selected telephone interviews. Given the relatively low return rate of questionnaire responses, it was not possible to reliably understand the national panorama in this area of study. The data that was collected, however, pointed to a wide variety of implemented procedures, initiatives and knowledge, with a disappointing trend toward very little environmental awareness, commitment and responsibility. Some solutions are available and are proposed in this work. The methodology used and the possible answers recommended in terms of application of environmental sustainability practices, motivational and organizational behaviors and education for sustainable development can be replicated in similar countries.

Keywords: Environment, Environmental management tools, Middle and high-school, Sustainability, School community.

1. Introduction

Private and public teaching institutions represent a privileged place to communicate ethical principles and knowledge to a large group of individuals. At the same time, educational institutions can be heavy economic and environmental mechanisms. While some authors like Sauvé (1996) have suggested long ago, having education for sustainable development (ESD) and UNESCO´s recommendations in mind, that "(…) the whole educational process should be re-shaped for sustainable development (…)", authors like Copley (2008), Gomes (2009), Namacau (2011) or Orr (nd), question the existence of a gap between the existence of different legal national and supra-national documents minding environmental regulations, and their actual implementation in the educational system.

Another approach that sustains the need for a strict analysis of the environmental management being done in the educational institutions is supported by the European Union (EU) regulation number 1221/2009, from November 25th 2009, structuring the volunteer involvement of organizations in a communitarian Eco Management and Audit System (EMAS). Decision number 1600/2002/EU from July 22nd 2002 should also be taken into account, since it identifies the need for the strengthening of volunteer partnerships between private and public companies as a beneficial approach to accomplishing the environmental goals of the near future.

From an environmental management point of view applicable in a teaching institution, three main tools can be appropriate: The EMAS, ISO 14001 norm, and the education-oriented tool *Eco-School* program, an approach already proved valuable in many countries (Huckle, 2013). The three support themselves in the "Plan-Do-Check-Act" (or PDCA) cycle with a retroactive approach. About EMAS, it is "(…) an EU management instrument developed by the European Commission for companies and other organizations to evaluate, report and improve their environmental performance (…)" (EMAS, 2014) and ISO 14001 a set of international (and voluntary) environmental standards witch provide the requirements for quality EMS´s in institutions. *Eco-School* initiative is an international program with *Agenda XXI local* based methodology and the aim to guarantee active participation of all children in the building of sustainable communities (ABAE, 2014).

Overall lack of awareness in society and educational institutions has been a problem and according to Alshuwaikhat (2008), explored in Disterheft studies (2011, p 99) "(…) it is essential to include opportunities for public participation, as the process will affect the whole institutional community, and (…) Environmental Management Systems (EMS), public participation and sustainability teaching (…)" are three important pillars in pursuing the goal of a sustainable future. In some countries, Switzerland being one example, most of the universities are obligated to submit annual environmental reports to contribute to the sustainable development of the society (Arvidsson, 2004), a requirement that should be followed by the other educational institutions for the same reason. Findings of the same author conclude that smaller institutions will more easily implement a successful EMS, given the better ability to mobilize the community around a goal.

Many authors like Arvidsson (2004), Barnes (2002), Bero (2012), Disterheft (2011) or Jabbour (2013), have developed their research in the last years in the area of university or college campus environmental sustainability, leading to a well-established study field and increased knowledge in the area. Some works (Hens, 2010; Kanyimba, 2014) help in solving environmental problems and reaching a sustainable future in the area of primary education. Searching for the same development of work in the area of public or private middle and high-schools will return a lower number of results, being some too broad (Warner, 2014), supporting the need for research in this field.

Accordingly to PORDATA[11] (2013), Portugal had in the 2012-2013 school year 411.238 students attending high school (Portuguese *ensino secundário* – 10th, 11th and 12th grades), 437.713 attending middle school (Portuguese *terceiro ciclo* – 7th, 8th and 9th grades) and 83.525 teachers supporting this student population. These students and teachers make up almost 9% of the entire Portuguese population. Portugal spends currently more than 6.2%[12] of its Gross Domestic Product supporting the educational system. Keeping in mind that in 2013 the country hosted almost 590 middle and high-school institutions, and that in Portugal alone almost 850 000 students (Pordata, 2014) study on a daily basis in the middle and high school establishments (higher-education hosted in 2013 371 000 students - 2.3 times less in comparison), a deeper reflection should be made in the area of implemented environmental sustainability of public and private middle and high-schools, the scope of this study.

This study investigates the global question of "how is environmental sustainability being perceived and implemented in middle and high-school institutions in Portugal?". An analysis model was built based on triangulation of data, supported by data collection through e-mailed questionnaire, telephone interviews and results discussed based on literature.

The results of this work will contribute to a better understanding of the actual "state-of-the-art" in terms of Portuguese middle and high-schools environmentally sustainable initiatives, highly related with education for sustainable development, and their results for a better environmental performance of the institution and their users. This study intends not only to help understand the commitment, knowledge, resources, organizational and planned behaviors and motivation of those involved with the teaching institutions in a daily basis, but also comprehend the importance of an

[11] PORDATA is a Portuguese official, up to date and certified statistical database about the country and EU, sponsored by Fundação Francisco Manuel dos Santos. Educational data can be accessed at http://www.pordata.pt/Tema/Europa/Educacao-27

[12] In report "Repensar o Estado – Algumas contribuições para a reforma da despesa pública", January 2013.

EMS as applied to traditional middle and high-school facilities in Portugal. Procedures and suggestions arose from the obtained results, discussion and conclusions.

2. Methods

A mixed methodology with emphasis in the qualitative research and multiple strategies were used (questionnaire, interview, pre-existent data). Quantitative and qualitative data were collected with the purpose to "(…) built a complex, holistic picture (…) reporting detailed views (of participants) and conducting the study in a natural setting" (Bogdan and Biklen - 1992). The questionnaire asked about general school and person information and environmental initiatives developed in the institution and it´s continuity, followed by questions about stakeholder´s involvement and a "other´s" group, where questions about existing interactions, EMAS or ISO 14001 norm knowledge, importance given to EMS, intervenient training and existing problems implementing environmental activities were asked. Open and closed questions, sometimes with a *Likert scale* approach co-existed in a semi-structured questionnaire.

To reduce observer and respondent bias and properly fit the desired goals of this investigation, an e-mailed questionnaire survey was conducted to the entire population of mainland Portugal middle and high-schools (583 institutions). Posterior telephone interviews to the institutions that have environmentally sustainable initiatives implemented were made to confirm and complement some of the answers given in the questionnaire. Statistically the sample had the purpose to be representative, impartial and stratified. Secondary and primary data collecting methods were used.

The chosen population were all middle and high-schools enrolled in Portuguese mainland educational institutions in the school year of 2012/2013 – with the data obtained from a bought database originated in the *Education and Science Statistical Office* (DGEEC) / Education and Science Ministry (MEC). The different contexts where, when possible, seen from an "insider" perspective in the interviews, not assuming preconceived hypothesis or assumptions. Every school worker opinion was considered to be important and intended to be taken into account.

The semi-structured questionnaire had open and closed questions, trying to avoid double-barrel or ambiguous questions and loaded or leading questions. Category type, ordinal and continuous questions, in terms of level of measurement, were used. The use of some recall-dependent questions was unavoidable and a *Likert scale* similar approach was used several times. Content, language, type and sequence of the questions were adapted to the target population.

An e-mailed questionnaire was chosen over paper survey, given the wide geographic area being covered, time and money restrictions, and the convenience to those being questioned. The questionnaire was tested to form a final document to be sent by e-mail to the chosen institutions. The e-mail was sent January 19th 2014. The questionnaire was to be answered by one element of each of the main representatives of the school "staff", being: management team, teachers, administrative personal and duties monitors. Tuckman´s (2000, p. 343) research was followed and explanations were given to the responders accordingly. A second e-mail was sent in an effort to increase returned e-mailed questionnaires, but telephone contact (as suggested by Dias *et all*, 2008) was not attempted given the limited time and large population.

Representing 20.4% of the initial population, 119 institutions were unable to be contacted, mainly due to outdated contacts in the bought database, since the decree-law n. º 75/2008, from the 22nd of April (Autonomy, administration and management organization system in schools) required schools to be organized in "mega groups" in the same geographical area, which led to several changes in the institutions e-mail contacts from 2009 to 2013.

After the e-mailed questionnaire data was collected and analyzed, specific answers were selected and some institutions were asked for an open-ended interview, with the purpose of adding richness of details to the investigation. This study approach chose to have an in-depth follow-up interview with thirty two selected educational institutions, collecting further information that would help to better understand if, and how, the schools have implemented their environmentally sustainable procedures. A semi-structured model for the telephone interviews was developed to support the theoretical framework of the research and allow flexibility in the answers. The interviews were recorded under permission of the interviewees and converted in digital files. Tesch´s (2002) ideas about de-contextualization of the process of interview were used: the collected volumes of data intended to be segmented in smaller “units of ideas, episodes or pieces of information” (p. 166). An effort was done in the re-contextualization process, enabling the researcher to observe the “big picture”. Any large volume of data collected was reduced to manageable amounts, for what systematic segmentation was used when possible. Data content analysis was then used, assuming that the audio and written files translate truthfully the interviewees´ opinions and knowledge. After a “floating” and free analysis of the texts, codification of the material was the option taken, trying as much as possible to classify, aggregate and categorize data with posterior triangulation of data in mind.

Inferential statistics and simple statistical techniques supported in *Microsoft Excel* were applied to analyze the data of the questionnaire. Bivariate analysis and cross-tabulation were computed as support of some data analysis. Reliability is assured by the accurate analyses of the results and their reproducibility. Once collected and analyzed, the data were translated into a quantitative analysis whenever possible. Content analysis, discourse analysis and relational analysis were done.

According to Valentin (2008) and supported in Bardin (1977), the lexical analysis in this research measures the different words and their incidence, comparing and identifying relationships. A classification with the objective of organizing the words in a comprehensible manner and creating levels of occurrence, with relative and absolute frequency calculated, was done, and texts were observed within the goals of this research. Those calculations were computed in Excel software.

3. Results

3.1. The Questionnaire:

The working sample includes 76 answers out of 464 e-mailed surveys, corresponding to a 16.4% return rate. However, since from the initial 76 answered questionnaires 11 were answered by different individuals from the same institutions, in reality only 65 different schools responded to the questionnaire, which corresponds to a 14.0% return rate. From those schools, 83% were public institutions and 17% semi-private or private institutions. In terms of representation the results are dependable, given that they correspond, in terms of area of the country, to the average distribution of schools supported in DGAE[13] (2014) database and *Ler em Português* mainland private schools database. In them, a public school distribution of 43% / 43% / 14% can be seen between the north, center and south of mainland Portugal. This study obtained respectively 47% / 43% / 10%. A private school distribution of around 38% / 50% / 12% can be seen in the same areas. This study obtained respectively 56% / 33% / 11%. No study was developed in the Açores and Madeira archipelago.

Given the new organization of the educational institution in Portugal in “Agrupamentos” or “Mega Agrupamentos” the majority of the schools had middle and high-schools students in the same institution. For this reason, a clear pattern or predominance of middle or high-schools answering the questionnaire cannot be established. When in this study analysis the response numbers are inferior to 76, this signifies that one or more interviewees did not answer that particular question.

[13] 2014 school codes database for candidates applying to public teaching institutions.

The answers to the majority of the surveys came from teachers (52%) and managing team (25%) being the number of answers from the maintenance staff of only 1%. 85% of the answers came from staff that works in their schools for at least 5 years.

In terms of environmental initiatives and sustainability promoting actions, 83% of the inquired population remembers at least one or more initiatives in his / her educational institution in the examined period, but 17% did not recall any environmental initiatives. 52% of the respondents remembers four or more activities.

The initiative the respondents remember most for causing the biggest positive impact were "Eco-Escolas" program, "Iniciativas Ciência Viva", "Clube do Ambiente" and also "others", making 73% of the overall initiatives. The EMS were the ones with higher weight between the remaining (9%). The reason for that positive impact range from the interest in the acquisition of Eco-Escolas "green flag"[14], environmental protection awareness, opportunity for teamwork, minimizing energy use, the ability to motivate staff for Solid Domestic Waste (SDW) separation, "Passing the message" in the community, the added value to the school facilities and the fact that some lab/practical work was done and some contact with nature existed.

The majority of the initiatives (92%) had its origins in the school, with no other intervention, being that only 3% of the initiatives had its origins in the municipality. As to the "others", they relate with *Parque Escolar* renovation work, *Olimpíadas do Ambiente* (promoted by Universidade Católica) and *Amb3E* initiatives.

The study found that 75 to 100% of the school population was included in the initiatives in 34% of the cases. 71% of all the relevant initiatives are focused on middle school students.

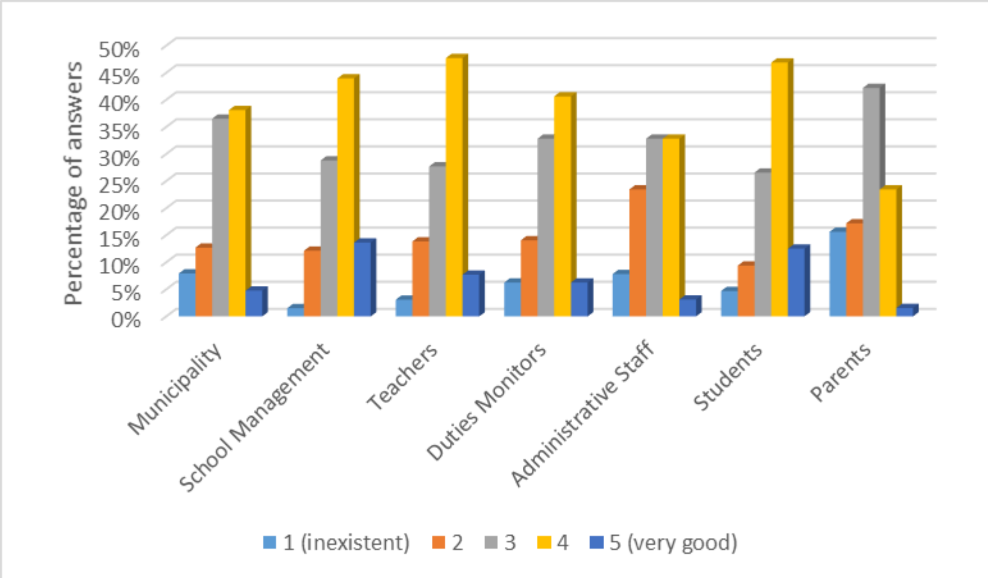
About 74% of the environmental initiatives were considered to have a *good* or *very good* (rated "4" or "5") "follow up" in the first year after they had been promoted. In the following years 13% of the answers (against only 3% in the same school year) consider that the "follow up" is *bad*.

47% of those answering the survey belong to an *Eco-School*. The results of the program were considered mainly "reasonable" or "good".

45% of the schools that responded to the survey do not have/do not know if they have an assigned environmental responsible in their institution. 12% of the schools lost the position or the person responsible for this position and 43% of the schools claim to have that position.

Figure 1 – Interviewees opinion about the engagement of the several school stakeholders in terms of environmental initiatives promotion and work in the institution.

[14] By gaining the "green flag" the School is recognized for doing quality work in the area of Environmental education / Education for Sustainable development.



The engagement of the several school stakeholders in terms of environmental initiatives promotion and work in the institution is higher in the case of the school management and students, being acceptable in the case of teachers and duties monitors (Fig.1).

It was also found that in 52 answers (73%) external to the institution partnerships were inexistent or not known in their institution, 3% lost that partnership and 25% do have some kind of active partnership implemented. Those that lost the partnership mentioned the lack of resources (materials) and the end of the established period for the partnership as the main reasons.

In regards to EMAS, 58 answers (89%) recognize that the person or institution does not know anything about the system nor is related with its procedures. 5 respondents (8%) know EMAS, but do not work with it and 2 answers (3%) stated that they worked with a similar system, indicating *Eco-Schools* audit scheme. As to ISO 14000 series certification norms, 48 answers (73%) state that the person or institution does not know the norm nor is related with its procedures, 16 answers indicate that the respondents know ISO 14001 norm but the person or institution does not work with it, 1 answer stated to have worked with this norm and 1 answer stated to work with a similar one, not specifying the name.

An EMS would be welcome in the institution they work/have worked in 73% of the answers, although 11 answers (17%) indicated that its application in the real world would be questionable. 17 interviewees (25%) do not have an opinion and 1 answer defended that the application of an EMS in the school would be impossible. Those answering that “the application of the EMS would be questionable”, “would be unnecessary” or “would be impossible to apply” support their answer in the lack of motivation, reduced readiness and poor collaboration (mainly between teachers), a sometimes huge variety of projects and activity demands, the need to attribute the project leadership to a permanent worker, the lack of environmental sensibility of the school population and the fact that “it is difficult” to bring awareness to some students.

The managing of the environmental challenges in the institutions is many times centered in a work group and then delegated in the institution workers (22%), being essentially cross-cutting to all the school community in many situations (32%). About the effort done in the last 4 year cycle with the aim of gaining skills and knowledge in the environmental and sustainability area, managing team and teachers collect the best results (Fig. 2).

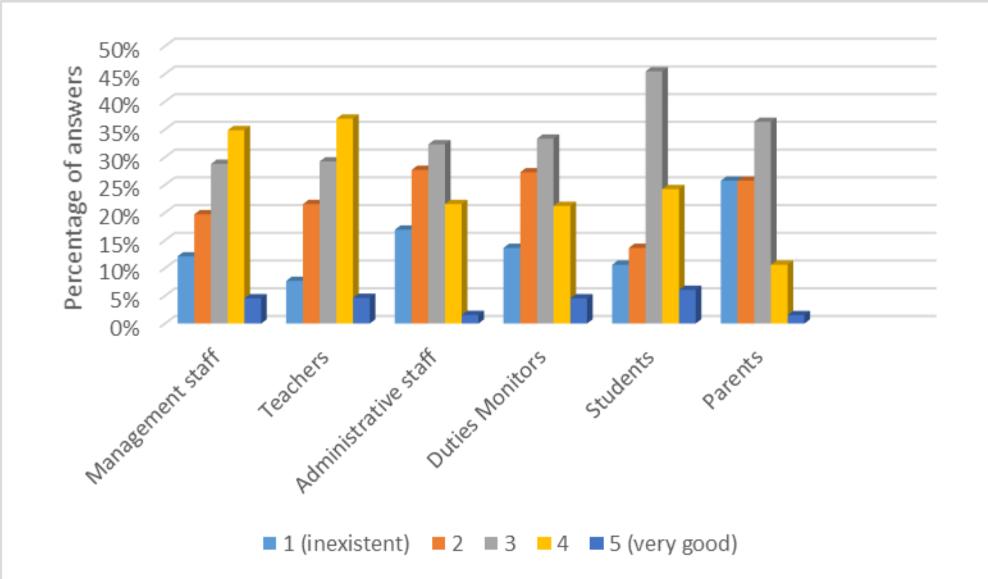


Figure 2 – General opinion about the effort done in the last 4 year cycle with the aim of gaining skills and knowledge in the environmental/environmental sustainability area.

The cause of the several difficulties faced when trying to implement environmental sustainability procedures are diverse, namely due to: management and/or teachers conflicts (30%), administrative staff (5%), duties monitors (9%), students (7%) or parents (6%) queries and lack of awareness, the absence of a “environmental subjects” responsible in the institution (20%), unnecessary bureaucracy (22%) and “others” (3%).

Peer evaluation seems to be the main driver for effective implementation of environmental activities in teaching institutions in 40% of the answers, followed by MEC evaluation and stimulus. Those answering “others” identify “changing the teaching staff” and “have prior knowledge of the applicability of the activities and projects” as the most important stimulus. Respondents had the opportunity to write “comments and suggestions” before ending the survey. Only one suggestion was written, namely the existence of an “environmental management office” in the school where several stakeholders from different areas would meet and discuss the topic.

3.2. The Telephone Interview

Understanding some of the functioning logic, organic and procedural details of the schools and triangulation of data were the important goals of the interviews to the 32 schools where environmental initiatives were identified. In 22 educational institutions (67%) it was possible to satisfactorily conclude about the questionnaire answers motivation and overall dynamic of the school. In the remaining 10 institutions it was not possible to contact the responsible for the questionnaire answers (preferable) or someone related with this person.

Results can be observed in Table 1 (next page), where three major themes (social framing, school dynamics and “questionnaire related”) frame nine categories (family income, behavioral problems, number of students, management assertivity, existence of professional qualification courses, “in line with the questionnaire”, major problems implementing activities, urgent areas of intervention and existence of *Eco-School* project). These nine categories frame different sub-categories with respective register units and category and global frequency (*fr)* in percentage.

Table 1 – Content analysis summary of telephone interviews[15]. fr = Relative frequency.

Theme	Category	Sub-Category	Register Units	fr %(category)	fr % (global)
Social Framing	Family Income	Medium to low income W/activities	9	56	41
		Medium to low income No/activities	2	13	9
		Medium income W/activities	4	25	18
		Medium income No/activities	1	6	4
	Behavioural Problems	No W/activities	5	83	23
		No No/activities	1	17	4
School Dynamics	Number of Students	small (0 - 500 students) W/activities	7	35	32
		small (0 - 500 students) No/activities	2	10	9
		Medium (501 - 1000 students) W/activities	4	20	18
		Large (1000+ students) W/activities	4	20	18
		Large (1000+ students) No/activities	3	15	14
	Management Assertivity	Strong W/activities	7	47	32
		Median W/activities	2	13	9
		Median No/activities	3	20	14
		Week W/activities	1	7	4
		Week No/activities	2	13	9
	Professional Qualificaion Courses	Yes W/activities	12	60	54
		Yes No/activities	4	20	18
		No W/activities	3	15	14
		No No/activities	1	5	4
Questionnaire Related	In Line with Questionnaire Answer	Yes correctly	3	17	14
		Partially correctly	5	28	23
		Partially incorrectly	3	17	14
		No	7	41	32
	Major problems Implementing Activities	Money related	4	16	NA
		Motivational (management)	2	8	NA
		Motivational (Teachers)	3	12	NA
		Motivational (Students)	5	20	NA
		Motivational (All community)	4	16	NA
		Work load	1	4	NA
		Excess activities	3	12	NA
		Lack environmental responsible	3	12	NA
	Urgent areas of Intervention	Partnership with private/public entities	1	5	NA
		Green spaces maitenance	2	9	NA
		Scheduled interventions cut short	4	19	NA
		Electricity	7	33	NA
		Water	4	19	NA
		SDW	3	14	NA
	"Eco-School"	Yes W/activities	11	61	50
		No W/activities	5	28	23
		No No/activities	2	11	9

Apart from the above presented data, interviewees expressed some opinions not framed in the above mentioned themes, but relevant nevertheless.

Crossing data between the type of management, district and number of environmental activities is purposeful since it can lead to important conclusions about the existing relation

[15] "Management assertivity" category was defined by the author based on written and telephone interviews interaction. Ability to define the environmental goals of the institution and express feelings and thoughts related to this subject, perceived honesty and clarity of the speech and anxiety revealed in the interview were taken into account.

between the different areas of the country and/or management type and the implementation of environmental activities. Table 2 allows for that comparison.

Table 2 – Relation between district, type of management and number of environmental activities. "M/N" - median assertivity with no activities, "M/W" - median assertivity with activities, "S/W" - strong assertivity with activities, "W/N" - weak assertivity with no activities and "W/W" - weak assertivity with activities. "Blank" indicates the number of educational institutions where management assertivity was not possible to quantify.

Count of Activities	Management						
District	M/N	M/W	S/W	W/N	W/W	(blank)	Grand Total
Beja						1	1
Braga	1		1				2
Coimbra			1	1			2
Faro			1			1	2
Guarda						1	1
Lisboa		1	1	1			3
Porto					1	2	3
Santarém						2	2
Setúbal	2	1					3
V. do Castelo			2				2
Vila Real			1				1
Grand Total	3	2	7	2	1	7	22

4. Discussion

In terms of public / private and semi-private ratio of schools, an 83% / 17% correlation was obtained in the questionnaire, when accordingly to *Ler em Português*[16] 2012 / 2013 database, the relation was around 70% / 30% in 2009, excluding strictly professional training institutions and music schools. This difference slightly reduces the confidence degree of our results. In terms of the desired stratification of answers, the majority of the answers came from teachers and the managing team (77%), not allowing for the desired broad conclusions. The number of answers from duties monitors (1%) can lead us to conclude what level of importance is given to their opinion and at what level the information is getting to the support personnel.

17% of the respondents did not recognize any environmental initiative in their institution. 47% of the interviewees belong to an *Eco-School*, institutions more aware or motivated to develop environmental work. The overall amount of Eco-Schools in Portuguese middle and high-school institution is much smaller than our 47% response rate, easily confirmed in the 2013 – 2014 list of Eco-Schools (ABAE, 2014) reason why the number of schools with "no initiatives" could be even higher in reality than what is reflected in this study. Cross-checking data with the interviews led to the conclusion that 32% of the telephone-interviewed institutions did not agree with the responses

[16] Detailed data from 2009 available in http://www.lerportugues.net/np4/escolas.html.

in some questionnaire answers, especially the “absence of environmental initiatives” question. This led the reflection that the true number of schools that answered the e-mailed questionnaire and stated that they didn´t have environmental initiatives may be smaller than the 17% that the initial questionnaire results show.

A clear pattern can be seen about the origin of the identified initiatives - 92% had origins in the school - with no other intervention, and only 3% of the initiatives had its origins in the municipality. The assumption that no serious approach or connection is being made with the private or corporate structures of the areas around the schools can be made. This situation can frankly limit the environmental approach of the institutions, given that they are many times the ones that have not only the knowledge but also the initiative to promote and structure environmental enterprises at school level.

The research showed that 71% of all the environmental initiatives that happen in the school focus on middle school students. More focus should probably go into high-school initiatives and contacts established with public or private institutions, who can provide these students with more technical knowledge and a clear picture of what’s happening in terms of environmental initiatives, in ‘real-world’ application.

The follow-up of the initiatives in the years after the one where the initiative was promoted is a possible area of improvement also. Reinforcement activities in pre-planned periods, questionnaires like *Olimpíadas do Ambiente*, communication about the performance of the projects or plans and participatory monitoring and evaluation can be possible solutions to this problem. The follow-up should always be part of the initial work plan.

Not only is the existence of a sustainable development coordinator one way of assuring continuous community involvement in environmental initiatives, but also one way to make the promotion of activities more effective, given that decisions are more centralized. An ‘eco-team’, comprised of teachers, administrators, duty monitors, parents and students, represents another way to promote environmental education and the continuity of environmentally sustainable actions. In this way, the transdisciplinary approach defended by Hansmann (2010) would for sure be applied in many more situations, especially if different agents of society work together at this level. Suggesting the existence of a full-time sustainable development coordinator doesn’t seem to be a realistic approach, although it is desirable.

The *facilitator* position that many times municipalities can assume when dealing with the relation between schools and other private or public companies is of major importance. Private and public companies could allocate resources, within their possibilities, to help and involve the country´s educational institutions in a deeper manner. In a more broad and superior level, it is the Portuguese government´s role to promote and facilitate the aforementioned connections, creating, for example, tax incentives or positive synergies in these areas.

Active partnerships implemented (25%) correspond many times to recycling companies who collect SDW, not above and beyond what is or should be done in the everyday life of the community. The existence of two schools that have active partnerships with environmental consultancy companies is one step forward that could represent another positive path to follow.

Focusing on EMAS or ISO 14001 processes, it was possible to conclude that none of the respondent´s institutions are using these systems, and only a very small percentage of the school population related with the environmental area knows about their existence. A discussion can be made around the need to better inform the school workers about the existence and application of these tools, giving the more committed ones the opportunity to go one step further in relation to the simplified *Eco-School* program and an even bigger step when considering the normal “every-day” environmental management of the institutions. The 73% of answers that consider positive the implementation of an EMS in their institution consider it an opportunity to take the next step in terms of environmental management in educational organizations in Portugal.

School management, teachers and students are the ones recognized to be more engaged in the environmental initiatives, and can, because of that, be the front line of the changing movement towards a more sustainable education. Their success seems however to depend on the existence of implicit or explicit guiding plans, clearly framing intentions that will control future actions and induce or control (up to a certain point) volitional behaviors, as explored by Ajzen (1985, p11-12).

About the type of environmental program management implemented in the analyzed schools, no well-defined approach was recognized, even when comparing questionnaire results and telephone interviews, situation that is in line with the work of Fialho (2009) and Quintas (2012). Nevertheless, “top-down” methodologies could be recognized in 46% of the cases. When a well-defined methodology joins with an assertive management and a participatory approach, positive results emerge. Understanding the cognitive, behavioristic and social dimensions of organizational behavior explained by Luthans (2011, p20-23) can be of major importance here.

In the quest for environmental knowledge and training in the area of environmental sustainability, no member of the school community stood out clearly and positively. Parents, administrative staff and duties monitors are the ones with poorest results in this area.

Based on the results of this study and literature review from authors like Amirtham (2013), Aragão (2014), Namacau (2011), Quintas (2012) or Samuel (2010), it becomes clear that communication within the school community should be clear and the motivation and goals of the managing team should openly stand out and lead the way. Poor civic training and social involvement is also a target here. Bureaucracy should be reduced to the minimum, supporting short hierarchic chains, electronic and e-mailed simple procedures, and making the best possible use of the available information.

Possible lack of time and human resources would be minimized by organizing small teams of different areas / subjects and allocating non-teaching time for the environmental issues purpose. Having prior knowledge of the applicability of the activities and projects can also be an incentive for the effective application of environmental measures. Cross-checking the collected data, no clear trend was possible to be seen in respect to the size of the organization and the implementation of environmentally sustainable measures, although the initial researched studies suggested so.

The seven specific principles of the third article of the Portuguese law 19/2014, from April 14th, do not seem to be taken into account at the ideal level of action in the Portuguese educational institutions. Also, this research seems to point to a less positive attitude toward some of the other Portuguese environmental law main ideas and lines of action when dealing with educational institutions. European Union regulations (Directives n.º 1221/2009 – Nov. 25th; 1600/2002 – Jul 22nd, among others) seem not to be explored to their maximum potential if accounting for the volunteer involvement of organizations in management and audit systems, or the need to strengthening volunteer partnerships between private and public companies. Production, publication and analysis of detailed reports verified by external authorities about the sustainable development of institutions and their environmental performance is only a small and partial reality, mainly supported in the *Eco-Escolas* program.

This study support´s the work of Orr (nd.), Copley (2008), Namacau (2011) and Gomes (2009), when questioning the existence of a gap between documents like the National Plan of Action for Energetic Efficiency (PNAEE), National Energy Strategy (ENE) or the National Plan against Climatic Changes (PNAC) and their real-world application in the educational institutions. Institutions should ask if they are not doing exactly what Moreira da Silva (2013) feared, i.e., allowing for the actual problems and economic crisis to be an excuse to postpone or fail in preparing a sustainable future. This “monetary” approach can instead be a catalyst for the desired change, since resource use can be managed in order to save money.

Socioeconomic status and the number of students is not a factor in regards to the environmental commitment and implemented sustainability measures at the school. Management assertiveness, nevertheless, seems to have a clear positive correlation (fr category = 47%) with the implementation of environmental initiatives. An even bigger positive correlation (fr category = 60% and fr global = 54%) was found between the existence of professional qualification training and the development of environmental initiatives and implemented environmental sustainability, suggesting the need of this kind of educational approach as one possible pathway to achieve proper implemented environmental sustainability. This strong correlation was even more noticeable in the telephone interviews, since the initiative and development of many of the environmental sustainability improvements in the educational institutions is attributed to the professional development training, given the need of those involved to develop and apply their knowledge.

The fact that the existence of professional education in some educational institutions amounts to a larger funding appropriation from the education ministry, allowing to allocate more money to different environmental projects, is also one explanation for the positive correlation stated in the last paragraph. Institutions with no relevant environmental initiatives, but with professional programs, are the ones who´s professional programs do not have an environmental or technological component in the curricula. Namely, sociocultural animation practices, chef and kitchen, public relations, amongst other humanities-based professional courses.

Some of the interviewees understood the concept of “EMS” as a single, or a set of simple and sometimes loose initiatives, that could somehow be related to the environment, and some of the interviewees understand the concept of an applied EMS with the existence of over-simplified *Eco-School* related initiatives. The same can be said about the existence of energy saving systems in the school buildings.

About the problems in the implementation of environmental initiatives identified through content analysis of the interviews, money related problems correlate with the inability to conclude started projects, sometimes with the municipality support, inability to proceed to structural works in electrical, water or other facilities and generally with the constraints and inability to economically support people and materials needed to develop projects that can generate environmental gains. Strict management of the school finances seems to be one alternative not completely explored yet, and the indication of one of the interviewees, where all the schools operating expenses and available budget should become public, can be debated. Allocating a larger amount of resources by the central government to this cause or the implementation of dedicated and well-managed EMS would be a help in this area. Connecting environmental efforts with social benefits, renting roofs to external entities with the purpose of installing solar panels or carbon and environmental footprint calculations and diagnosis are possible lines of work and research.

Although the work-load doesn’t seem to be a serious problem, excess of activities and the lack of a sustainable development coordinator in the institution were highlighted problems, being that the latter can many times be one solution for the former problem.

Motivational problems are the ones that pose the biggest problems and according to some of the interviewees these are the ones that more easily corrode the implementation of many projects. Student lack of motivation, weak management and Education Ministry inputs, and excessive time spent with the development of inconsequent activities are some of the problems that should be solved.

All the interviewed institutions that belong to *Eco-School* program had implemented activities in the environmental area, highly variable in environmental importance and school community´s involvement. These data seems to support once more the importance of the *Eco-School* program as the starting point for any more developed EMS.

Having in mind a careful management of educational institutions when comparing them to other small to medium companies in terms of efficiency, this study recognized several parallelisms: on the positive side, short hierarchical chains are common (the “environmental responsible” reports many times only to the principle). Multitasking is recognized to some degree, since management team and teachers are often solely responsible for the research, development and promotion of the environmental activity. On the negative side, appropriate training is not given to the school community nor is the quest for it encouraged in the workers of the institution. Environmental goals, when existent, are often not clearly communicated. This situation, sometimes side-by-side with bureaucracy does not help in the aforementioned lack of motivation. Adaptation to new situations didn´t seem easy. Lack of motivation due to constantly changing government employment policies and poor working conditions are having an important negative role. The needed motivation of the staff, readiness to accept proposals and provide proper feedback and the conditions for the engagement of the personnel, as suggested by Soleimani and Tebyanian (2011), allowing for the implementation of new ideas, is not readily found in the data collected.

The practices and principles suggested by Pinheiro (2009) and Videira *et al* (2007) about environmental management tools, were not found in the majority of the studied examples. The support for this can be found in the lack of interaction with local corporations and institutions, as well as the lack of sustainable socio-economic experiences provided by the educational institutions or external entities. The relative (and sometimes total) lack of control of the impacts of atmospheric emissions, SDW, indoor air quality, thermic or luminous pollution are real and the sustainable use of the built existent spaces is not so common as could be expected with the available EMS´s, knowledge and innovation. Several questionnaires and interviews lead us to discuss about the fostering of the efficient use of resources in many situations, which is without no doubt positive.

Flexibility, according to Bero (2012) is the key when dealing with EMS in educational institutions, and a comprehensive step-by-step approach can be the methodology to implement in our national educational institutions. Aiming for environmental excellence and environmental sustainability, with the return on economic and environmental benefits inherent to this approach, will most likely demand adapted legislation. This legislation should frame simplified environmental management systems in the short-term and the aforementioned step-by-step approach, progressing to more demanding and ambitious organizational systems in a consolidated way.

The implementation of a developed EMS in educational institutions, with the purpose of joining efforts to reduce environmental impact and economic costs, increasing sustainability, seems to be not only needed, but desired and essential. The changes should be gradual to allow for the adjustment of all stakeholders and the testing of procedures and implemented modifications. Initial tests in pilot-schools should be conducted and a three-step approach should be implemented.

5. Conclusions

In this study it was explored the implemented environmentally sustainable practices, attitudes and perceptions in Portuguese middle and high-school educational institutions, through a questionnaire survey and posterior interviews. The fact that more than 10% of the respondents did not had any kind of environmental initiative developed in their institution in the last 4 years, is a worrying reality. More research should be done in this area to obtain accurate conclusions and act accordingly.

Many environmental initiatives developed in public and private institutions are of minimal impact and commitment, given the educational, social and cultural expectations of a European country. The need to standardize the number and quality of these initiatives arose from this research if aiming to develop responsible and sustainable societies is in mind.

Empowering duties monitors and administrative staff with environmental sustainability knowledge is an important step forward in the environmental management of an educational institution, given their professional functions. Organizing the development of the environmental knowledge needed for the active and productive participation of all the stakeholders will allow for a competitive advantage in the institution and country.

Almost 97% of the environmental initiatives developed in the schools had their origins in the school (and remained "closed" in the school) or represent minor interventions by external entities. In order for schools to have a broader environmentally sustainable approach to development, a closer connection between the schools, municipality and private institutions is needed.

More focus should also be put in the development of high-school targeted initiatives, with the purpose of creating a continuum of knowledge and action from middle-school. To include the business and working market in the planning can be a good option. A work-plan with reinforcement activities in pre-planned periods, questionnaires like *Olimpíadas do Ambiente*, communication about the performance of the projects or plans and participatory monitoring and evaluation, together with an also pre-planned follow-up, will allow to improve the continuity of environmental initiatives.

The existence of a sustainable development coordinator is desirable and should be encouraged in every institution. Equally, multidisciplinary teams should gather periodically to discuss the environmental management of the institution. These two entities should ensure continuous stakeholder involvement, more effective promotion of environmental activities and an active participatory approach at all levels.

Almost no one from the school community knows (or understand the purpose) of the existence of developed EMS like the EMAS or ISO 14001. This seems to open a door for training in the area and possible synergies between the Educational and the Environmental Ministries. Most schools consider positive the implementation of an environmental management system. Having an active partnership with environmental consultancy companies can be an important help in terms environmental management of the institution and future development of an EMS at EMAS or ISO 14001 level.

The lack of motivation of some staff is related with the Science and Education Ministry evaluation and stimulus. A collaborative approach with individual stimulus and evaluation along all the educational hierarchy is a preliminary point to implement. Strict management of priorities, well defined management goals with proper organizational and planned behavior and the existence of the sustainable development coordinator are important. Assertive management and participatory approaches, together, stand out positively in terms of results. The need for future analysis of institutional organizational behaviors (at micro - individuals, meso – work groups and macro levels – organization) arose.

The existence of professional qualification training for students in educational institutions, especially with a strong component of environmental knowledge and technology in their curricula, has a strong correlation with the existence of environmental initiatives in the educational institutions. They seem to act as catalysts for many of the activities

Portuguese schools face economic constrains, so resource saving through efficient use of resources and environmental management implementation measures could be an important driver to enhance environmentally sustainable practices. Educational institutions should be the first to implement the concept of environmental democracy, promoting green entrepreneurism at the school level. Parents should be called to participate in more activities in order to act side-by-side with their children with environmental education in mind. The municipality or even central government should act not only as a partner but also as a catalyst of partnerships, leading to future environmental sustainability. Efforts should be dedicated not only to solve existing problems, but also in the mitigation of future ones, through well-defined strategies. Good regulation with proportionality and transparency of procedures in mind, accountability for decisions, consistency and targeting the defined goals is required.

All of these suggestions could be implemented slowly and in an integrated way to try to contribute to the improvement of the actual environmental performance and education of middle and high schools in Portugal.

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Towards Transformative ESD Assessment at Business Schools

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Abstract

Business schools are increasingly engaged in providing education for sustainable development (ESD). This increase of ESD implementation also leads to an augmented need for and use of ESD assessment tools. However both conventional assessment and appraisal systems for business schools as well as sustainability assessment tools seem to fall short when it comes to monitoring and evaluating ESD. Even though sustainability assessment tools have the potential to stimulate ESD in higher education, they tend to overshoot the mark or even work counterproductive. This paper aims to outline the basic features of an alternative way of assessment that will strengthen the implementation of ESD within business schools. Based on a narrative literature review, this paper identifies the features of what is called 'transformative' and 'transmissive' management & business ESD (M&B ESD) and of current and 'ideal' sustainability assessment tools. The findings result in a matrix that shows that current sustainability assessment tools are not congruent with transformative M&B ESD. The same matrix indicates the features of a type of assessment that would be supportive of the implementation of transformative M&B ESD. The findings also suggest that the characteristics that M&B ESD ideally should avail of are in line with the features of second order change, whereas the prerequisites for a form of assessment that is supportive of M&B ESD do equal the features of double-loop learning. Hence, in order to ensure that M&B ESD is really 'transformative', business schools should engage in a process that combines ESD implementation aimed at second-order change with ESD assessment aimed at double-loop learning.

Keywords: Higher Education for Sustainable Development, Management & Business Education for Sustainable Development, sustainability assessment tools, organizational learning, organizational change

1. Introduction

Within the field of higher education for sustainable development (HESD), management and business education holds a special position (Figueiro and Raufflet, 2015). While recognizing that there are various other providers of management and business education, this article focuses on business schools as they provide training and education to both future and current business leaders and thus can be regarded as a very important influence on how businesses operate (Lee and Schaltegger, 2014; Morsing and Rovira, 2011; Rasche et al., 2013; Slater and Dixon-Fowler, 2010).

Business schools have increasingly been criticized for contributing to unethical and unsustainable practices in the corporate world. One of the main points of critique is that business schools form business leaders with a single-minded and short-term view on the pursuit of profits (Amran et al., 2010; Ghoshal, 2005; Giacolone and Wargo, 2009; Morsing and Rovira, 2011; Swaen et al., 2011).

To address this critique, incremental changes are not enough. Instead, business schools should contribute to a paradigm shift by radically changing their curricula (Barber et al., 2014; Muff et al., 2013; Örtenblad et al., 2013; Rasche et al., 2013).

If transformation is the objective of ESD within business schools, this has implications for both the implementation and assessment of M&B ESD. Therefore, the main question of this paper is how the features of M&B ESD implementation and sustainability assessment tools should relate to each other in order to contribute to a transformation towards sustainable development. First the features of what is called 'transformative' and 'transmissive' M&B ESD are identified and then the current and 'ideal' features of sustainability assessment tools are explored. The findings are combined to indicate the features of a type of assessment that would strengthen the implementation of transformative M&B ESD.

Concerning HESD, the few overview articles that have been published, have different scopes and focus on various aspects of (M&B) ESD implementation and assessment (e.g. Ceulemans et al., 2015b; Figueró and Raufflet, 2015; Fischer et al., 2015; Karatzoglou, 2013; Leal Filho et al., 2015; Shriberg, 2002; Wals 2014; Yarime and Tanaka, 2012). This article distinguishes itself by combining broad explorations of the features of both transformative (M&B) ESD and sustainability assessment tools. Thus, this article draws from and extends the literature in these two fields, with the aim of building a stronger link between the two.

2. Methods

The article is based on a narrative literature review. This method is suitable for reinterpretating or interconnecting many studies on different topics and allows for post hoc theorizing (Baumeister and Leary, 1997). Indeed, this article covers a large variety of papers, that use different methods and address various issues within the field of HESD – the latter resulting from the fact that this paper addresses both implementation and assessment of (M&B) ESD.

2.1 Literature search and selection

As the review explores the features of transformative M&B ESD on the one hand, and ESD assessment on the other hand, the literature search and selection was conducted on these two strands (see below). For both strands, the search was done through the electronic databases worldcat (through the virtual library of Tilburg University) and Google Scholar. The references of the selected literature were searched as well, which provided some related relevant literature (although this often overlapped with the articles already found through the databases). In addition, some relevant book chapters and reports have been added. Only publications in English have been included. As both developments and literature concerning (M&B) ESD have expanded enormously over in this century, the search was done for literature published between January 2000 and January 2016.

2.1.1 Searching and selecting articles on transformative (M&B) ESD

The abovementioned databases have been searched for articles in peer-reviewed journals with a focus on 'transformative ESD' in higher education institutes (HEIs) and business schools. As 'transformative' is usually not mentioned explicitly in the title and keywords of an article, the search was conducted by using the more general search terms 'education sustainable development', 'education sustainability', 'business schools sustainability', 'business schools csr', business schools ethics', 'management business education sustainable development', 'responsible business education', responsible management education'.

A first selection was made based on titles and abstracts, and the remaining articles (over 200) went through desk review in order to make a further selection of articles that are about transformative HESD ánd that either implicitly or explicitly provide features of such transformative HESD. Inclusion criteria concerning the transformative aspect were authors stressing that:

- ESD, HEIs and/or business schools should contribute to a paradigm shift towards sustainability;
- ESD requires a holistic approach and has major consequences for the role, focus and/or culture of the organization concerned;
- An important goal of ESD is training change agents;

Articles with a very specific focus on one discipline that was not management or business related (e.g. technology) were excluded, as were book reviews. In the end, 41 articles were included.

2.1.2 Searching and selecting articles on (M&B) ESD assessment

The abovementioned databases have been searched for articles in peer-reviewed journals concerning the assessment of HESD implementation, using the search term 'education sustainability' with the addition of 'assessment', 'assessing', 'evaluation' and 'evaluating'. Given the focus on implementation of (M&B) ESD, articles on the assessment of education limited to the evaluation of one particular program or module were excluded. Even though sustainability reporting can be considered a form of sustainability assessment, reporting was not included in the search, because the focus is on features of sustainability assessment tools that have been developed for education. Some 60 articles went through desk review and the final selection contained 24 articles.

2.1.3 Deriving features

All selected articles have been thoroughly studied and the features have been derived by hand search (i.e. making notes, mindmaps, cross-reading). This was done because of the 'vague' nature of transformative HESD (as explained above) and because sometimes different wordings are used for the same concepts. Also this approach allowed for interpreting and comparing texts.

2.2 Limitations

One of the pitfalls of a narrative review is that the author is biased and only includes literature that is supportive of his/her argument or conclusion (Baumeister and Leary, 1997). The author recognizes this pitfall, as she has a normative stance towards ESD and is in favor of the transformative approach described in the review. However, as the objective of the review is to list the features of transformative (M&B) ESD, the focus on the body of knowledge that promotes this approach to ESD seems justified. In addition, the fact that the used articles were searched 'by hand' may be considered subjective (and possibly inaccurate).

Another limitation may be the approach to the review: its aim is not so much discussing the various contributions, but looking for the common ground concerning the features of transformative M&B ESD and assessment. Thus, critique on the methodologies and findings of the selected articles is not included in this article.

Furthermore, this article is based on the assumption that business schools influence how their alumni manage businesses. However, there are also scholars that have criticised especially MBA programmes for being irrelevant in this regard (Slater and Dixon-Fowler, 2010).

3. Results

3.1 Features of transformative Management & Business Education for Sustainable Development

As M&B ESD is HESD within the context of management and business education, this paragraph first addresses transformative HESD in general, whereafter some aspects are highlighted that are of particular importance in the context of business schools. From this, the most important features of transformative M&B ESD are derived.

3.1.1 Higher Education for Sustainable Development

When comparing the selected literature on transformative HESD, authors mention a number of recurrent features that HESD should avail of in order to really contribute to a paradigm shift towards sustainable development.

3.1.1.1 Built-in / horizontal approach

An obvious and relatively easy way for higher education institutions to address ESD, is to develop specific courses and programs on sustainability that are offered in addition to regular courses and programs, often as electives. Such a 'bolt-on' approach has increasingly been criticized as it would only improve the sustainability literacy of those who are already interested in sustainable development and hence opt for these courses (Tilbury, 2012; Disterheft et al., 2013), i.e. a form of preaching to the converted. As this criticism gained ground, a 'built-in' approach started to be promoted, which does not only concern the integration of sustainability in existing courses, but also implies a reorientation of teaching and the renewal of curricula and learning methods (Rusinko, 2010; Stubbs and Cocklin, 2008; Waas et al., 2012). The concept of transformative learning (learning as change) resonates with the built-in approach, as it requires the understanding and integration of various worldviews as well as inter- and transdisciplinarity (Wals, 2009; Wals, 2010).

More or less similar concepts are what others call the 'horizontal' and 'vertical' integration of sustainable development. Vertical integration equals the bolt-on approach, while horizontal integration is similar to the built-in approach, i.e. the integration of sustainable development within different courses of the curriculum, based on an interdisciplinary and holistic view approach to sustainable development (Ceulemans and De Prins, 2010).

Based on the data generated in the second phase of the DESD monitoring and evaluation process, Wals (2014, p.14) concludes that the built-in approach is now 'heavily favoured by ESD proponents' and that a sole bolt-on approach to ESD seems to become extinct.

3.1.1.2 Competences

This shift towards a more holistic approach and a reorientation of curricula and pedagogy, implies also a shift from providing knowledge to training competences. Several authors have listed competencies for sustainable development (Barth, et al., 2007; Rieckmann, 2012; Wiek, et al., 2011). Lambrechts et al. (2013) observe that there seems to be consensus on the main characteristics of competences for sustainable development amongst the different authors and provide the following overview: responsibility (values, ethics, reflection), emotional intelligence (transcultural understanding, empathy, solidarity, compassion), system orientation (interdisciplinary), future orientation, personal involvement (self-motivation, motivating others, learning), and the ability to take action (participatory skills). Hesselbarth and Schaltegger (2014) provide a competency matrix based on the results of a literature review in combination with a survey amongst sustainability management professionals and list strategic, systems thinking, anticipatory, normative and interpersonal competences as key. Of all listed competences, systems thinking stands out (Harpe and Thomas, 2009; Rieckmann, 2012; Stubbs and Schapper, 2011; Vermeulen et al., 2014).

3.1.1.3 Role of educators

The focus on a built-in approach and the training of specific competences has major implications for teaching and learning. The acquisition of competences is hardly comparable with learning as knowledge acquisition. This has resulted in growing attention for the role of faculty and lecturers in ESD, leading to the distinction between '*Education* for Sustainable Development' and '*Educating* Sustainable Development' (Barth and Rieckmann, 2012; Ceulemans and De Prins, 2010; Wals, 2014), the latter meaning that educators must be able to facilitate and support others in the acquisition of ESD competences and a holistic mindset (following the built-in approach). Based on their analysis of an academic staff development program, Barth and Rieckmann (2012) conclude that 'the competence development of academic staff is an essential prerequisite for a sustainability paradigm shift in higher education' (p.28). Similarly, Lozano et al. (2013) stress the importance of 'Educate-the-Educators' programmes.

3.1.1.4 Contextualization

The competences related to ESD are also criticized for having been selected by 'Western' scholars and thus reflecting a certain worldview and context. As a consequence they may lack meaning in other contexts (Mochizuki and Fadeeva, 2010). Hence, the selection of competences needs to take place in local contexts, so that they can build on cultural beliefs and values. However, the inclusion of beliefs and values may be sensitive, as on the one hand awareness of one's values is essential when it comes to influencing behaviour, but on the other hand discussing values in education could easily lead to accusations of ideological indoctrination (Murray et al., 2014; Stubbs, 2013).

The issue of contextualization can be stretched to ESD in general, as the academic debate is heavily dominated by scholars from Europe, North America and Australia (Karatzoglou, 2013; Leal Filho et al., 2015). In order to make ESD more relevant and meaningful for educators and students with values and beliefs rooted in 'non-Western cultures' it is important to better contextualize teaching and learning concerning sustainable development, and to take into account local and indigenous ways of life and knowledge systems (Helu Thaman, 2010). Le Grange (2011) pleads for a view of ESD that enables to integrate and transform Western and indigenous knowledge.

3.1.1.5 Inter/transdisciplinarity

Interdisciplinarity (cutting across academic disciplines) is regularly mentioned as an important feature of transformative HESD (Barber et al., 2014; Barth et al., 2007; Harpe and Thomas 2009; Parker, 2010). However in addition, also the need for transdisciplinary collaboration is stressed (Barth and Rieckmann, 2012; Disterheft et al., 2013; Lozano, 2006; Lozano et al., 2013). Addressing complicated, real-world sustainability problems requires the involvement of various stakeholders throughout society, which would open up academic education and research to transdisciplinary collaboration (Yarime et al., 2012). Such collaboration with stakeholders may also help the abovementioned contextualization of concepts and competences (Vermeulen et al., 2014).

3.1.2 Management & Business Education for Sustainable Development

When looking at the literature concerning M&B ESD, a number of aspects stand out in comparison to the literature on HESD in general.

3.1.2.1 Strong and weak sustainability perspective

Especially in M&B ESD, the perspective from which sustainability-related issues are approached does matter. An important distinction in this regard is that between 'weak' and 'strong' forms of sustainability. Weak sustainability is a minimalist view and builds on the current neoclassical paradigm instead of questioning it. It does not seek to fundamentally change the organization and operations of businesses, but instead promotes some alterations to current practices that make them less harmful to the environment and/or society. Strong sustainability is about a radical change that leads to a different way of life and as such requires the construction of a new paradigm and alternative business models. (Springett, 2005; Von der Heidt and Lamberton, 2011)

In terms of M&B ESD, curricula that are based on a weak sustainability perspective often address the more practical and technical aspects concerning eco-efficiency and corporate social responsibility, while curricula based on a strong(er) perspective also include underlying questions about the role of business and the training of competences such as critical thinking and reflexivity (Von der Heidt and Lamberton, 2011). Perhaps even more important, the 'strong' approach is strongly normative and values-based, which is often considered as inappropriate or indoctrinating within 'traditional' management and business education, which likes to present itself as neutral and free of values (Springett, 2005; Stubbs, 2013). When comparing these features with those of the built-in and bolt-on approaches to ESD, weak sustainability links to the bolt-on approach and strong sustainability relates to the built-in approach.

3.1.2.2 Educational disconnect

If sustainable development is taught in separate courses next to 'traditional' business courses with a neoclassical worldview, chances are that completely disconnected perspectives are offered, which is also called a 'pedagogical gulf' or 'educational disconnect' (Carrithers and Peterson, 2006). On the one hand, the 'traditional' courses are based on a neoclassical paradigm that promotes unlimited economic growth through the operation of free markets and increasing consumption of products and services, with a focus on short-term financial performance and profitability. Within this view, the environment (natural resources) can be understood as a subsystem of the economy. On the other hand, in courses on sustainable development –

especially when taught from a strong sustainability perspective - the economy is presented as subsystem of the environment. Free-market, business-as-usual operations are linked to harmful environmental and social externalities. As a result, students may feel that business and sustainability are inherently in conflict. Being unable to link the different perspectives, they either take a side or do nothing with the offered material (Barber et.al., 2014; Carrithers and Peterson, 2006; Remington-Doucette et al., 2013; Stubbs and Cocklin, 2008).

In order to avoid such an educational disconnect and to enable students to internalize sustainability into their (business) activities, it is important that they gain insight in the various worldviews, assumptions and interpretations that underlie the contents of the courses, using a built-in approach (Amran et al., 2010; Stubbs and Cocklin, 2008).

3.1.2.3 Language and metaphors

In addition, there is the danger of the educational disconnect being reinforced by the use of language concerning management and business vis-à-vis sustainable development. Audebrand (2010) explains how one of the main sources for models, analogies, and metaphors in strategic management education has been the domain of warfare/military practice and theory. The 'state of war' is widely used as the basic metaphor for business activity by scholars and in business, with words and phrases such as *target, attack, capture, declare victory, defend, lead the charge, strike*, etc. The vocabulary stresses, if not promotes, competition and adversarial relationships. This has potentially negative ramifications for sustainable development, as in this field collaborative relationships are imperative. If business students are enabled to find new metaphors, it may help them to come to terms with a reality in which sustainable development plays an important role and it may stop the perpetuation of assumptions and connotations underlying the old (neoclassical) business discourse (Kopnina, 2014).

3.1.3 Features of transformative M&B ESD

Based on the abovementioned literature, ESD has the potential to contribute to a paradigm shift towards sustainable development, provided it comprises of a built-in approach, including an interdisciplinary approach to course content and teaching methods and a number of competences, of which systems thinking is crucial. Transdisciplinary cooperation is important in order to be able to address the complex issues of our time. The same goes for M&B ESD, with the remark that the built-in approach is even more important, because it can better integrate concepts, bridge different views – including the strong sustainability perspective - and thus avoid an educational disconnect. Exploring different thinking, metaphors and paradigms concerning business and sustainable development forms an essential part of this approach. As all the abovementioned features have consequences for course contents and teaching methods, training academic staff in how to transmit ESD is essential. The following table summarizes the main features of transformative M&B ESD in the right column and lists the opposite features as 'transmissive' M&B ESD in the left column.

Table 1. Summary of main features of transmissive versus transformative M&B ESD

Features of transmissive M&B ESD (builds on current practice)	**Features of transformative M&B ESD** (aims at paradigm shift towards sustainable development)

• Bolt-on approach; additional courses on sustainable development, often electives	• Built-in approach; integration in existing courses and structures
• Same teaching and learning methods (aimed at what to think)	• Reorientation of teaching and learning methods (aimed at how to think)
• Providing knowledge; often related to eco-efficiency	• Competences such as systemic thinking, long-term perspective, reflexivity, …
• Educating students	• Educating-the-Educators
• 'One-size-fits-all' approach	• Contextualization
• Mostly disciplinary focus; hardly stakeholder involvement	• Interdisciplinary and preferably transdisciplinary; broad stakeholder involvement
• Weak sustainability perspective	• Strong sustainability perspective
• Focus on parts of the system	• Holistic/systemic view
• Does not question assumptions and world views; builds on current paradigm and structures	• Questions assumptions and world views
• Language and metaphors relate to conflict	• Language and metaphors relate to cooperation

3.2 Features of (M&B) ESD assessment

Conventional university assessment and appraisal systems hardly pay any attention to sustainability (Mader, 2012; Wals, 2014; Yarime et al., 2012). However, with the now widespread acceptance of ESD and an increasing number of Higher Education Institutions (including business schools) that claim to integrate ESD, there is also a growing need to demonstrate and measure what is being done in this field and what it yields (Barth et al., 2011). To this end, some conventional university assessment and appraisal systems have been adjusted, but mostly separate sustainability assessment tools have been developed.

This section will not provide a detailed discussion of all the different tools that are currently available. Instead, based on the selected articles on ESD assessment, their most important features and shortcomings are derived.

3.2.1 Separate sustainability assessment tools

There are currently some 20 sustainability assessment tools for higher education available, based on various methodologies (including self-assessment and external assessment, rating and ranking - or league table - approaches, often involving certification) and different scopes (ranging from operational issues to academic issues, and using different concepts on which indicators are based) (Disterheft et al., 2013; Fonseca et al., 2011; Kamal and Asmuss, 2013; Lambrechts, 2015; Waheed et al., 2011). Fischer et al. (2015) note that over the years, these tools '(...) have developed from compliance-oriented approaches focussing solely on the domain of operations to broader, more contextual and place-based explorative approaches, to systematically developed, comprehensive approaches allowing for inter-organisational certification and/or benchmarking' (p.788). Sustainability assessment tools are meant to have three main functions for a university: 1) understanding where it stands with regard to sustainability objectives; 2) identifying areas and developing strategies for improving its sustainability performances; 3) helping to build a culture committed to sustainability (Nixon, 2002, in Yarime and Tanaka, 2012).

Concerning M&B education, there are few rankings that focus specifically on sustainability. Between 2001 and 2012 the Aspen Institute published the biennal 'Beyond Grey Pinstripes MBA ranking', that was based on a survey on courses offered and articles published concerning social and environmental impact. Since 2003 Corporate Knights publishes yearly what is currently called the 'Better World MBA Ranking'. This ranking used to be limited to Canada, but since 2013 it is international. Based on the three indicators curriculum, institutes & centres and faculty research, Corporate Knights aims to identify which MBAs best equip graduates to change the world for the better.[17]

3.2.2 'Assessing' the ESD assessment tools and rankings

Despite their purpose of strengthening ESD, sustainability assessment tools have been seriously criticised. Already in 2002, Shriberg reviews 11 sustainability assessment tools and concludes that they mainly focus on operational eco-efficiency instead of education, that they do not effectively communicate on methods and results, and neglect the underlying motivations of the institutions concerned (Shriberg, 2002).

Ten years later, Yarime and Tanaka (2012) review 16 sustainability assessment tools and come to a conclusion that is in line with Shriberg's observations: Similarly, Disterheft et al. (2013) state that 'ranking/assessment tools and evaluation procedures focus on economic numbers instead of sustainably oriented governance models and future-oriented curricula/learning and teaching approaches' (p.19). In their comparative analysis of 12 sustainability assessment tools, Fischer et al. (2015) confirm that most indicators and criteria still relate to operations.

Interestingly, Madeira et al. (2011) note that sustainability tools seem to be too qualitative and lack quantitative methodologies, but as described above and below, most studies argue the opposite.

In reaction to the missing attention for curricula in sustainability assessment tools, Lozano developed in 2007 the 'Sustainability Tool for Assessing UNiversities' Curricula Holistically' (STAUNCH®) as an alternative. The tool is based on the analysis of explicit published course documentation, which however also forms its potential weakness, as Lozano notes himself: 'SD education delivered in the classroom but not reflected in the course documentation will not be captured' (Lozano and Young, 2013, p.135). Also pedagogical approaches (such as experiential learning, problem-based learning, group work and role play) as well as the quality and effectiveness of the ESD-related curriculum content are not identified by STAUNCH® audits (Glover, 2011).

Derrick (2013) and Jones (2012) point out that the use of sustainability assessment tools, especially in the form of ratings and rankings, may even work counterproductive. They stress the risk that the marketing purpose of these tools may become more important than the purpose of strengthening the development and implementation of ESD. Hence, the focus of an institution shifts from assessing and improving ESD towards obtaining a higher place in the ranking or an additional star in the rating. Management will steer on gathering and improving only those data that are required for the ranking or rating. Usually these data relate to eco-efficiency and governance and are based on quantitative indicators that can be measured on the short-term. Little attention and appreciation is left for ideas and initiatives on ESD that cannot be captured in ticking the required boxes. As a result, (M&B) ESD will translate into a top-down, short-term, technology focused set of quick fixes, which will hinder a truly built-in approach.

In addition, Jones (2012) describes how universities can be ranked at the top of league tables (such as the British People&Planet Green League) whilst their sustainability performance consists mainly of policy promises and lacks systemic stakeholder engagement. Universities with top sustainability rankings or ratings are externally rewarded and thereby legitimized for having met certain sustainability criteria, which may well disguise a very limited and instrumental implementation of ESD.

Furthermore Derrick (2013) notes that because indicators must be comparable and need to be measured on the short term, two elements that are very important with regard to sustainable development, namely time (need for a long-term focus) and local context (taking into account different circumstances) are generally missing in sustainability assessments.

[17] http://www.corporateknights.com/reports/2015-global-sustainable-mba/2015-global-mba-methodology-14299685/ accessed March 3, 2016).

Such lack of room for contextualization was also perceived by the member universities of ProSPER.Net (Promotion of Sustainability in Postgraduate Education and Research Network) a network of some 20 academic institutions in the Asia-Pacific region, that has the reorientation of business schools as one of their aims. They felt constrained in their development by what they perceived as the one-size-fits-all approach of mainstream university ranking and rating systems, consisting of Eurocentricly defined criteria. In order to overcome these constraints, the Alternative University Appraisal (AUA) project was launched in 2009 and followed in 2012 by the SUSTAIN (SUSTainability Appraisal for Academic Institutions) project (Fadeeva and Mochizuki, 2010; Razak et al., 2013). Based on a review of existing university ranking and rating systems, the Alternative University Appraisal system aims to facilitate and encourage engagement in ESD, to enhance its quality and impact and to provide 'benchmarking tools that support the diversity of missions as well as offering a framework for sharing good practices and facilitating dialogue and selfreflection' (Razak et al., 2013, p. 147). An important underlying rationale is also the perceived conflict between the competitive nature of rankings and ratings and the need for collaboration that is inherent to the concept of sustainable development.

Another disadvantage of sustainability ranking and rating systems is that participating universities hardly share the underlying information with their stakeholders and the wider public. If the information is shared at all, it is usually only done so by the ranking or rating organization and by the universities that achieve high 'scores'. Moreover, the information published usually concerns success stories. Again, such lack of information sharing is not conducive to creating a culture of transparency, accountability and mutual learning. In order to foster such a culture, sustainability reporting may be much more effective than sustainability ranking and rating (Fonseca et al., 2011). Based on his personal experience, also Adams (2013, p. 388) pleads for increased accountability, improved (management of) performance and more innovative approaches through sustainability reporting.

3.2.3 Current and ideal features of M&B ESD assessment

Above has been described how – according to various authors - both conventional university assessment and appraisal systems and sustainability assessment tools seem to fall short when it comes to monitoring and evaluating M&B ESD. From the discussed literature, the main shortcomings of sustainability assessment tools can be derived; they have been summarized in the left column of table 2 below. By reversing these shortcomings, also the 'ideal' features of assessment can be indicated, which has been done in the right column of table 2 .

Table 2. Shortcomings of current sustainability assessment tools as opposed to 'ideal' features of assessment

Shortcomings of current sustainability assessment tools	**'Ideal' features of sustainability assessment tools**
• Focus on operations/eco-efficiency	• Focus on (impact of) education, research and pedagogical approaches
• Based on quantitative data	• Including qualitative data
• Describing 'what'	• Describing 'why' and 'how'
• Short-term focus, static	• Long-term focus, process
• 'One-size-fits-all' approach	• Contextualization
• No/limited stakeholder involvement	• Broad stakeholder involvement (internal and external)
• Stimulates competition	• Stimulates cooperation
• Lack of accountability and transparency	• Ensuring public accountability and transparency

In the next paragraph the features of M&B ESD are compared to those of sustainability assessment tools.

4. Discussion

When comparing the features of transmissive and transformative M&B ESD as summarized in table 1 with the current and 'ideal' features of sustainability assessment tools as summarized in table 2, it is striking how the shortcomings of current assessment tools link to the features of transmissive M&B ESD, while the 'ideal' features of sustainability assessment tools are strongly congruent with the features of transformative M&B ESD. Hence, the current features of sustainability assessment tools will henceforth be called 'transmissive assessment', and the 'ideal' features will be called 'transformative assessment'. The connection between the four concepts can be visualized in a figure with two axes: the horizontal axe representing the continuum from transmissive to transformative M&B ESD and the vertical axe representing the continuum from transmissive to transformative assessment. Thus, a matrix with four quadrants is created, as visualized in figure 1 and described below.

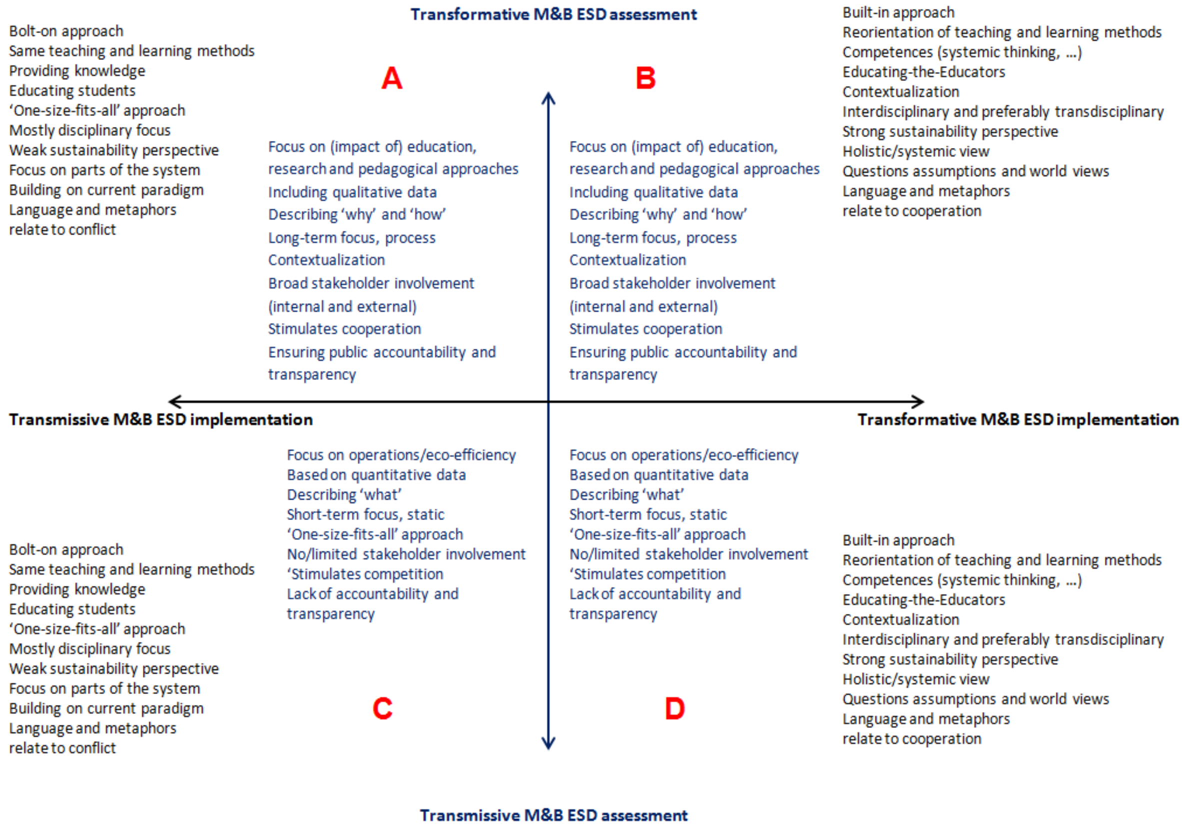

Figure 1. Matrix of transformative versus transmissive M&B ESD implementation and assessment.

4.1 Transformative versus transmissive M&B ESD implementation and assessment

Quadrant A is unlikely to occur in practice at this moment, as a business school with transmissive M&B ESD implementation will probably not be open to forms of transformative assessment. However, if transformative assessment be linked to for example PRME reporting or business school accreditation, it may trigger business schools to reconsider their ESD approach and help them moving towards more transformative implementation.

Quadrant B reflects the combination that is most likely to lead to a paradigm shift: both M&B ESD implementation and assessment are transformative and because of this congruency it is likely that they will reinforce each other.

Quadrant C shows that current sustainability assessment tools are very suitable for business schools that implement transmissive M&B ESD. In this case, the congruency will confirm the status quo and not lead to a paradigm shift.

Quadrant D shows the gap between transformative M&B ESD and current assessment tools. A business school in this quadrant aims to implement transformative ESD and uses current transmissive assessment tools to monitor and evaluate this implementation. Because the features of assessment and implementation are opposed to each other, the assessment will not be supportive of and may even withhold the implementation of transformative ESD. Hence, it will be very difficult for such a school to contribute to the aimed at paradigm shift towards sustainable development.

As indicated, one of the main functions of sustainability assessment tools is helping to build a culture committed to sustainability (Nixon, 2002, in Yarime and Tanaka, 2012). Quadrant D of the matrix shows that in the context of transformative M&B ESD, the current sustainability assessment tools do not have this function because of their transmissive features. In other words, current sustainability assessment tools are not conducive to a paradigm shift towards sustainable development, which is the purpose of transformative M&B ESD.

4.2 Link to organizational change and learning

Several authors indicate that in order for ESD to contribute to a paradigm shift, a broader organizational change is required within the HEI concerned. In their systematic review of the literature on sustainability in higher education with an emphasis on management education, Figueiro and Raufflet (2015) find that organizational change is the most frequently mentioned challenge in the articles analyzed. Implementation of HESD should not only take place at the levels of research, learning and teaching, but be part of a broader organizational change (Barth, 2013; Holdsworth and Thomas, 2015; Lee and Schaltegger, 2014; Palma and Pedrozo, 2015). Moreover, Barth (2013) stresses that organizational learning is increasingly seen as key to organizational change. In their study of the relationship between sustainability reporting and organizational change management for sustainability in higher education, Ceulemans et al. (2015a) highlight that HEIs could make much stronger use of sustainability reporting as a dynamic tool to plan the change towards sustainable development.

Not related to ESD, but in the general context of universities, Boyce described already in 2003 how continued organizational learning is essential to achieving and sustaining change in higher education. She argues that true change requires a combination of second-order change[18] and double-loop organizational learning[19] and that these two concepts are connected by 'examing assumptions, changing values and assumptions, and acquiring and practicing new competencies' (ibid., p.125). As described in the paragraphs on (M&B) ESD, the very same features are highly important to transformative M&B ESD as well. In the context of implementing PRME in business schools, Solitander et al. (2012) indeed argue that implementing a built-in approach to M&B ESD requires double-loop organizational learning.

When thinking along these lines, transformative M&B ESD can be seen as a form of second-order change and transformative assessment as a form of double-loop learning. In order to really contribute to a paradigm shift, M&B ESD should be a process based on both transformative M&B ESD implementation (enabling second-order change) and transformative ways of assessment (stimulating double-loop learning) that contains the characteristics as summarized in quadrant B of figure 1. This is added to the matrix, which results in figure 2.

[18] Questioning and challenging current values and assumptions, which not only leads to a change in actions, but also in the governing values, aims and processes behind these actions in order to contribute to a paradigm shift (Boyce, 2003).
[19] Organizational learning that includes questioning and challenging the (underlying assumptions of the) current institutional framework (Boyce, 2003).

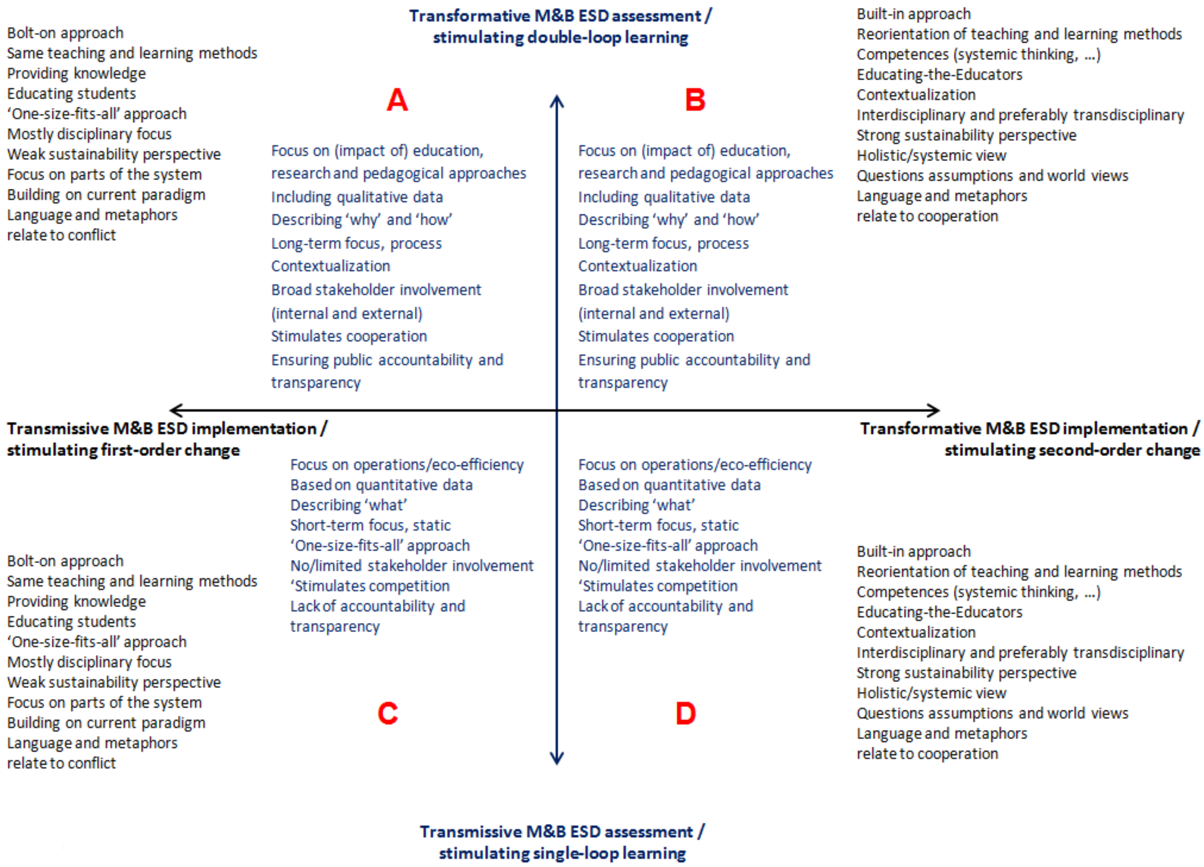

Figure 2. Matrix of transformative versus transmissive M&B ESD implementation and assessment linked to double-loop learning and second-order change.

Most business schools can still be placed in the opposite quadrant C, combining transmissive M&B ESD implementation (enabling first-order change) with transmissive ways of assessment (stimulating single-loop learning). They tend to apply the bolt-on approach and develop new programmes or courses to address sustainability, or revise individual modules, which are often offered as electives and are based on a weak view on sustainability (Barber et al., 2014; Godemann et al., 2011; Tilbury and Ryan, 2011). Coupling transformative M&B ESD implementation, assessment and organizational change and learning within a qualitative, long-term process is needed to help business schools moving towards quadrant B. The work of Mader (2012, 2013) and Palma and Pedrozo (2014, 2015) seems to include this coupling and would be relevant to apply in more empirical research.

5. Conclusions

The purpose of transformative M&B ESD is that business schools contribute to a paradigm shift towards sustainable development through their education. When comparing the features of transformative M&B ESD implementation with those of current sustainability assessment tools, it turns out that they are at odds with each other. This means that current sustainability assessment tools will not help and may even hinder business schools that strive for implementing transformative M&B ESD. In other words, current sustainability assessment tools are not conducive to a paradigm shift towards sustainable development.

Transformative M&B ESD is a long-term, qualitative process, with broad stakeholder involvement, through which the current paradigm, values and assumptions are being questioned and changed. In order to be able to monitor and evaluate such a process, sustainability assessment tools should avail of congruent features, as mirrored in quadrant B of the matrix that resulted from the narrative literature review.

The transformative features of both M&B ESD and assessment (quadrant B) are closely related to second-order change and double-loop learning. It is recommended that further research is done on the coupling of M&B ESD implementation, assessment and organizational change and learning within one transformative process. Theories and frameworks concerning organizational change and learning as well as process- and stakeholder-oriented types of assessment that could be used in the context of transformative M&B ESD need to be identified and tested.

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Indicators of Sustainable Development in Brazilian Capitals between 2000-2010

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Abstract

Sustainable Development Goals (SDGs) considers the economic, social and environmental dimensions, and one of the key challenges is eradicating poverty and hunger in the world. In this context, it is important to identify indicators of SDGs in Brazil to support public policies in order to achieve the goals and targets set for 2030. This descriptive and exploratory research aimed to calculate the differences between economic, social and environmental indicators in Brazilian capitals in 2000 and in 2010. The indicators selected were illiteracy rates, education level, income, vulnerability and housing, obtained in the electronic site of the Atlas Brazil. We used the software Estatística 7.0 to run cluster analysis and comparisons, and Principal Component Analysis. It was possible to verify the existence of clusters between geographically close capitals, with two clusters, one consisting of Southeast, South and Midwest capitals (G1) and another composed of North capital and Northeast (G2). Regarding the evolution of the indicators between 2000 and 2010 there was an improvement in SDGs indicators in Brazilian capitals except for Rio Branco and Macapá. In 2000, North and Northeast capitals had higher social inequality, greater percentage of extremely poor and vulnerable people into poverty compared to 2010. Among the capitals of the G1 cluster, Florianópolis, Porto Alegre, Curitiba, São Paulo, Belo Horizonte, Rio de Janeiro, Vitória, Cuiabá, Campo Grande, Goiânia and Brasília showed better indicators of SDGs. The analysis of main components and clustering, in the present study, showed that Brazilian capitals have improved since 2000. We concluded that there was an improvement in the indicators of living conditions, education, social inequality and health of the population in Brazil in 2010.

Keywords: Healthy environments, Sustainable development, Health promotion, Indicators, Public policy.

1. Introduction

The concept of the Sustainable Development Goals (SDGs) was born at the United Nations Conference on Sustainable Development, Rio+20, in 2012. The objective was to produce a set of universally applicable goals that balances the three dimensions of sustainable development: environmental, social, and economic. The SDGs replace the Millennium Development Goals (MDGs), which in September 2000 rallied the world around a common 15-year agenda to tackle the indignity of poverty.

The MDGs established measurable, universally-agreed objectives for eradicating extreme poverty and hunger, preventing deadly but treatable disease, and expanding educational opportunities to all children, among other development imperatives. The MDGs drove progress in several important areas, such as income poverty, access to improved sources of water, primary school enrollment and child mortality (UNDP, 2016).

Galvão et al 2016 suggest that the social environmental determinants of health are closely related to sustainable development; they are the societal conditions in which people are born, grow, live, work, play, ad age. They include early year's experiences, education, economic status, employment and decent work, housing and environment, and effective systems of preventing and treating ill health.

For post-2015 era, the challenge posed by the WHO is the reduction of health inequalities, which necessarily involve the social inequalities that concern the healthy environments and sustainable development (UNITED NATIONS, 2015).

The Agenda for Sustainable Development Goals has 17 goals and 169 to be achieved by 2030. The targets are relate to a world free of poverty, hunger, disease, fear and violence, with universal literacy, with equitable and universal access to quality education at all levels, to health care and social protection; a world committed to the human right, to safe drinking water and sanitation, among others (UNDP, 2016).

In order to achieve the SDGs, countries should establish indicators that address each recommendation. Comparative analysis of health, environment, economy and education indicators in time, are important to evaluate the evolution of those indicators.

Indicators are measures defined to represent a phenomenon to be studied, do not represent a number in itself, needs to be understood in context. "The indicator is part of the semantic information and cannot be presented as an isolated one" (AUGUSTO, 2002, p. 307).

Krank et al. (2013) wrote that the indicator systems consist of a purposeful selection of different indicators, whereas sustainability indices are formed by weighted and aggregated indicators. Sustainability indicators, indicator systems and indices are more than pure information and 'raw' statistical data: they have a normative character and should have implications for political decision-making.

Singh et al. (2012) presented some important indicators for measurement and monitoring of sustainable development: innovation indexes, knowledge and technology, levels of human and economic development, the ecosystem based indexes, indexes of sustainability of industrial performance, product indexes based on sustainability, sustainability indexes of municipalities, environmental indices for national and regional policies, environmental indices for industries, social indicators and quality of life and indices based on energy.

The evaluation of sustainability consists in provide subsidies to enable decision-making in the short and long term, in order to integrate nature and society. Thus, it appears that the indicators are meant to guide the evaluation and performance of municipalities, institutions informing the actual data relating to the dimensions for the publication of successes or change of strategic planning when not achieving the goals.

In this paper, we intended to verify if there were improvements in social, economic and environmental indicators in the 10-year period in different geographic regions of Brazil.

The aim of the present study is to compare social, economic and environmental variables in Brazilian capitals between 2000 and 2010.

2. Methods

This is a descriptive exploratory study with secondary data, using variables related to the Agenda for Sustainable Development Goals. Data of 27 Brazilian capitals in 2000 and 2010 were obtained from the website of Atlas Brazil (http://www.atlasbrasil.org.br/2013/pt/ranking/).

The indicators of Education were illiteracy (illiteracy rate between 11 and 14 years, illiteracy rate above 25 years) and years of study (18 to 24 with completed elementary school, 18 to 24 with completed high school education, above 25 years with completed higher education, percentage of children aged 0 to 5 years out of school and percentage of children aged 6 to 14 years out of school).

The indicators of Economy were income (per capita income, percentage of extremely poor, percentage of vulnerable to poverty, Gini Coefficient, unemployment rate of 25 to 29 years, percentage of employed with completed higher education with 18 years or more, municipal human development index).

The indicators of health were vulnerability (Life expectancy at birth, longevity of HDI, infant mortality, aging rate, dependency rate).

The indicators environment were housing (percentage of population living in households with toilet and piped water, percentage of population living in households with garbage collection, percentage of population living in households with electricity)

Data analyses were performed using Statistic software, version 7 (STATSOFT, 2004) to obtain Clustering analysis and Principal components analysis. These analyses are important tools for exploratory data analysis, as well as an attempt to understand the complex nature of multivariate relationships contained in the database.

The Wilcoxon test (CALLEGARI-JACQUES, 2003) was performed to evaluate the differences between variables in 2000 and in 2010. The level of significance adopted was 0.01.

3. Results

It was possible to identify the existence of clusters between geographically close capitals, 2000 and 2010 for the selected variables in 27 Brazilian capitals (Table 1).

The result of cluster analysis in Figure 1, shows, the formation of two clusters: G1 and G2.

In G1, capitals of Southern, Southeast and Midwest were clustered (in 2000) and North and Northeast capitals (in 2010).

In G2, capitals of all North and Northeast were clustered in 2000.

In G1, there is a subdivision into 3 clusters: **G1a:** the Southern, Southeast and Midwest capitals in 2010, Florianópolis 2000 and Palmas 2010; **G1b:** the capitals of the Northeast and Brazil in 2010; **G1c**: the Northern capitals in 2010, Southeast, South and Midwest in 2000, with the exception of Florianópolis and Palmas.

That means that in G1, are clustered the capitals with better life expectancy, higher indicators of employment, Human development Index, Longevity Human development Index, level of education.

In G2 were two subdivisions: G2a: Northeast capitals in 2000, with the except for Maceió and São Luis and G2b: North capitals in 2000, Palmas, Maceio, São Luís in 2000.

That means that in G2, are clustered the capitals with high percentage of illiteracy indicators above 25 years and high percentage of people vulnerable to poverty and extremely poor.

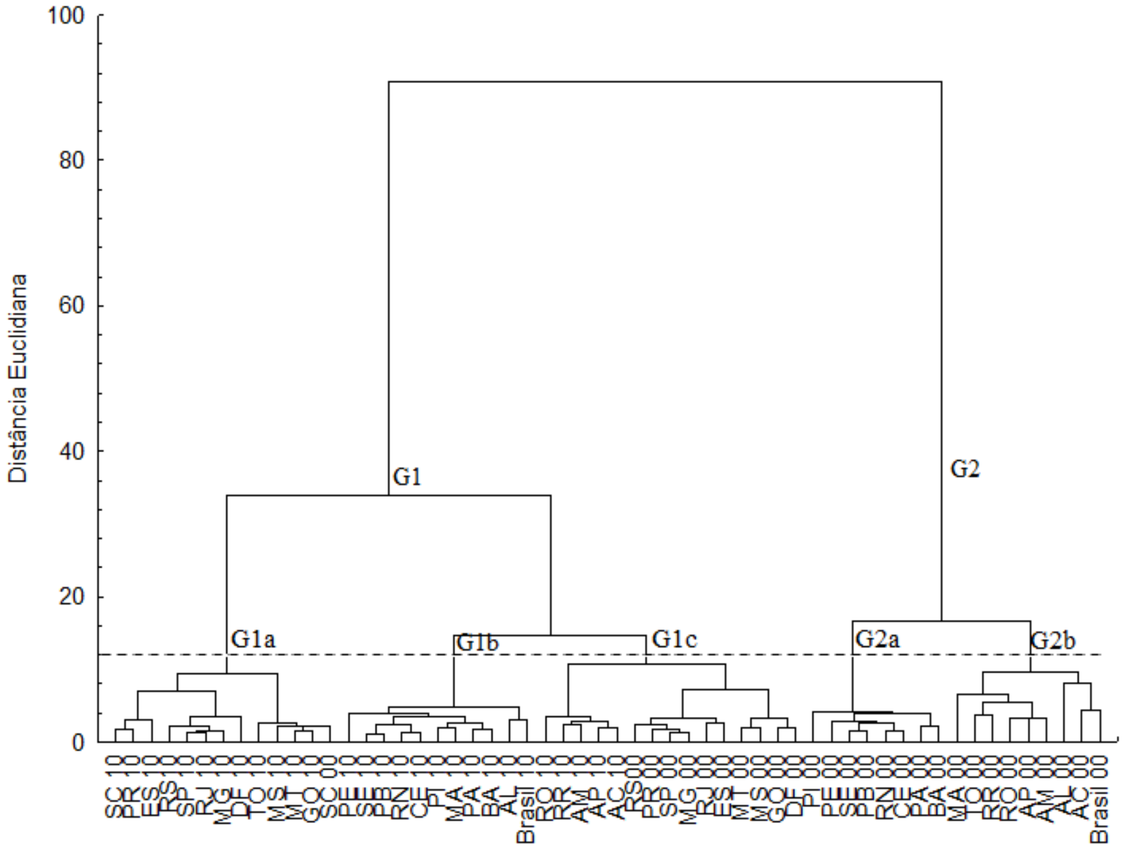
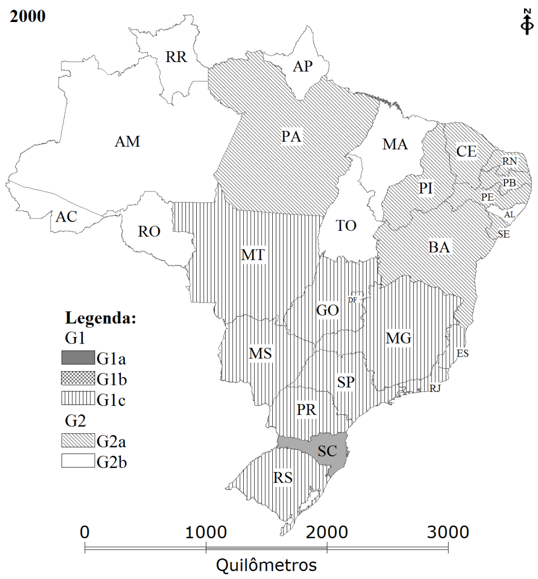


Figure 1: Dendrogram of division of the Brazilian capitals into two clusters and their subdivisions.

In Figures 2 and 3 is possible to observe the changes of the cluster of the capitals between 2000 to 2010, characterizing the diference of the indicators in those two period.



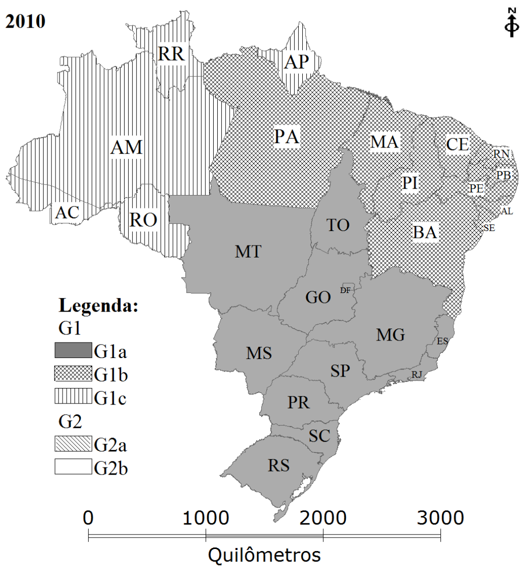


Figure 2: Spatial distribution of sets of Brazilian capitals in the clustering of the analysis of in 2000.

Figure 3: Spatial distribution of sets of Brazilian capitals in the clustering of the analysis of in 2000.

In Figures 2 and 3 it is possible to observe that in 2000, the State SC, Santa Catarina, where Florianopolis is located, had already better indicators compared with all the other capitals. These better situations of indicators were only reached by other capitals in 2010.

The analysis of the Main Components, confirms the results obtained in the clustering analysis as shown in Figure 4, where are observed the variables associated with the clusters, allowing to view the relation of the indicators with the location of the capitals in the quadrants.

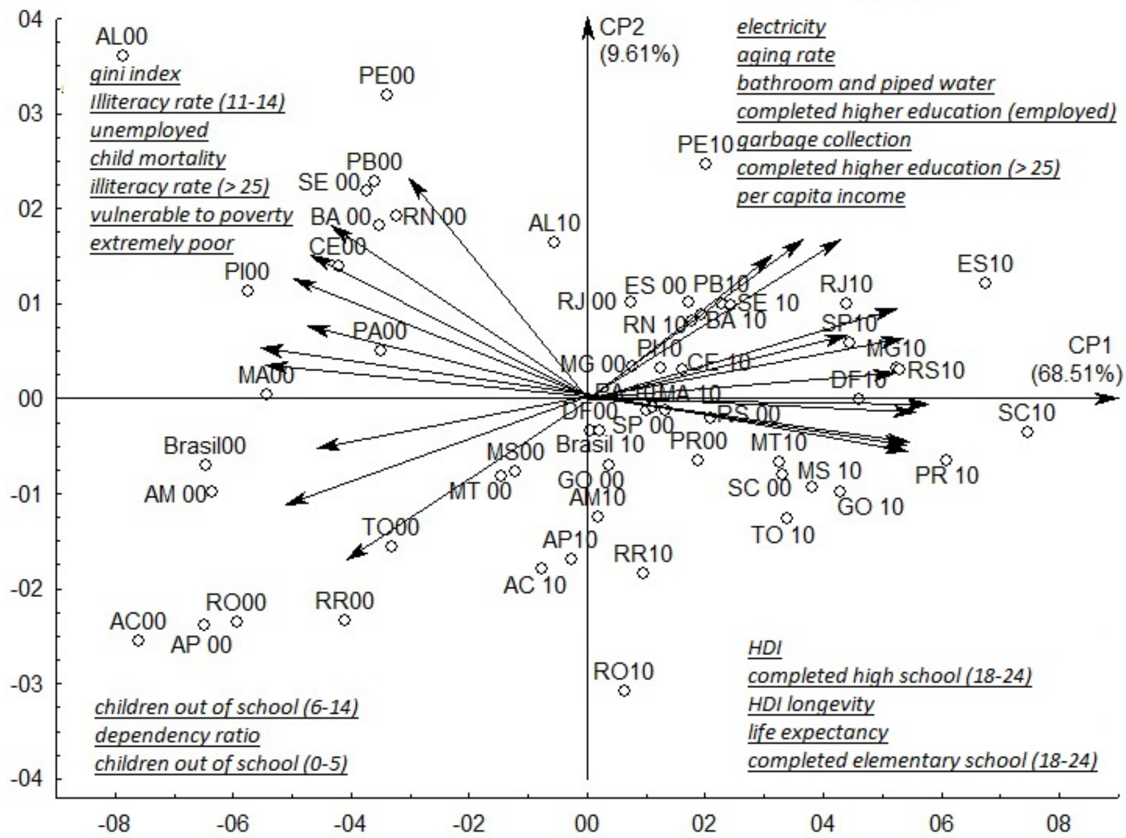


Figure 4: Two-dimensional graph with the distribution of the Brazilian capitals according to economic, social and environmental indicators constructed with two Principal components.

According to the Principal Component 1 (CP1), most of the capitals of the G1 cluster (right of the graph), especially G1a, presented, as greater discriminatory power, the percentage indicators of employees with completed higher education, life expectancy, HDI, HDI longevity, people with completed elementary and high schools between 18 and 24 years old and people with completed higher education above 25 years.

According to this CP1, the capitals of G2 clustering (left side of the graph) are characterized by higher illiteracy indicators above 25 years and higher percentage of vulnerable to poverty and extremely poor.

The Principal component 2 (CP2) discriminates (upper left right of the graph) the capitals of G2a cluster and Alagoas (AL) in 2000. This cluster is characterized by high rates of Gini, high unemployment rate, high illiteracy rate from 11 to 14 years, high infant mortality rate, and high rates of extremely poor and high amount of people vulnerable to poverty.

The most part of G2b cluster (lower left of the graph), characterized by low rates of children out of school between 0 and 14 years and dependency ratio, respectively.

The CP2 showed, also (upper right of the graph), the capitals with high percentages of households with electricity, bathroom and piped water and high aging rates.

In G1c cluster, there are capitals (right of the graph), in a transition from left to right. In this cluster, the capitals with indexes from 2010 showed intermediate characteristics in the movement of the left of the graph in 2000 to the right of the graph in 2010.

The indicators with greater discriminatory power for negative indicators were children out of school (0-5).and (6-14) and dependency ratio.

4. Discussion

The SDGs recognizes that social inequality as a major factor to fight in order to move forward and achieve the goals proposed for 2030 (UNITED NATIONS, 2015a).

The indicators selected as variables in the present study, in the Brazilian capitals are related to some of the 17 Sustainable Development Goals (SDGs).

The analysis of main components and clustering, in the present study, showed that Brazilian capitals have improved since 2000, its indicators of education, economy, health and housing.

Brazil has improved its capacity to formulate, implement, monitor and evaluate multi-sectoral and universal public policies in the last twenty years, with the implementation of universal health care and conditional cash transfers. These policies have resulted in the improvement of the health indicators of extreme poverty and hunger, under-five mortality, maternal health, infectious diseases, and primary education coverage (ANDRADE, 2016).

In Education, main aspects with better indicators were illiteracy, years of study and lowered the number of children aged 0 to 14 out of school.

In Economy there were improvements in per capita income, in Gini Coefficient, unemployment rate of 25 to 29 years, percentage of employed with completed higher education with 18 years or more and municipal human development index (HDIM). There were a significant reduction in number of extremely poor and vulnerable to poverty.

The indicators of health also improved in life expectancy at birth, longevity of HDI, infant mortality, aging rate, dependency rate.

In housing, there was a decrease in number of population living in households with toilet and piped water; in households with garbage collection and population living in households with electricity.

Florianópolis had the best indicators since 2000. This capital has have the best social inclusion ranking: access to and acquisition of goods and services, better education levels, lower exposure of young people to violence (BARROSO, 2001). The presence of the Transdisciplinary Research and Development Center of the Federal University of Santa Catarina could have contributed to improvement of public policies.

There was a huge improvement in the indicators since 2000 in most of the Brazilians capitasl, however Rio Branco and Macapá still have lower indicators, in relation to other capitals.

The improvement of the indicators are a result of policy actions that gave access and maintenance of students (0-5 years and 6-14 years) in schools; as well as the decrease in numbers of the inactive population - dependency ratio. Although, between 2007 and 2014, the North and Northeast regions registered decrease in the percentage of students with 4 or more years of age on the public school (PLANO NACIONAL POR AMOSTRA DE DOMICÍLIO, 2015).

Palmas in 2010 also deserves attention, having similar indicators in comparison to the capitals of the Southeast region. This is due to HDI of 0.788 in 2010, which places the city in the High Human Development range. The indicator that most contributed to this result was the Longevity with 0.82 index, followed by Income: 0.789 and Education: 0.749. The capital also ranks 16th among municipalities in HDI (BRAZIL, 2013).

The capitals of Southeast, South and Midwest regions had similar indicators and were clustered togeter. These capitals are located ate the most economically developed region, accounting for 75% of Brazil's GDP, with diversified economic activities: agriculture and livestock, various industries segments, and development of scientific research (DINIZ, 2009). Noteworthy are also the infrastructure and sanitation, availability of piped water and electricity.

All the capitals of the Northeast needs political investments in relation to social inequality, evidenced by the variables: Gini index, percentage of extremely poor and vulnerable to poverty, as well as education, especially regarding literacy, as evidenced by the illiteracy rate among people with 11 to 14 years and over 25 years, employability evidenced in the number of unemployed rate with completed higher education, health of childhood evidenced in infant mortality rates.

In 2010, according to our results, it was observed that the selected indicators in the capitals have improved, as evidenced. The government social programs in the period favored the improvement of indicators in these capitals, such as the income transfer policy to families to fight poverty and misery, Benefício de Prestação Continuada, Previdência Rural and Bolsa Família program (BRAZIL, 2010a)

The Brazilian income transfer programs such as Bolsa Família, was highlighted in the 2014 Human Development Report (UNITED NATIONS IN BRAZIL, 2015b).

Like Brazil, there was a change in the world situation with a significant decrease in the number of people in extreme poverty from 1990 to 2015. “Progress towards the MDGs has, on the whole, been remarkable. With regard to extreme poverty, for example, the number of people living on less than US$ 1.25 per day has declined by more than half, from 1.9 billion in 1990 to 836 million in 2015” (WHO, 2015b, p. 5).

Concerning investments in education, the Ministry of Education, from 2000 to 2007, was among the ministries with higher government spending, with the most of spending destined to scientific research (BRAZIL, 2010a).

The illiteracy rate among people aged 15 or more years in 2012 and 2014 period, showed a significant decrease having a higher rate among the age cluster above 40 years, because literacy in adulthood is more difficult to achieve (PLANO NACIONAL POR AMOSTRA DE DOMICÍLIO, 2015). The reduction of illiteracy rate are results of actions taken in National Plan of Education for democratization of education, such as the obligation of education for children aged 6-14 years and the broader access of early childhood education (PLANO NACIONAL DE EDUCAÇÃO, 2014).

On the world stage in relation to education and the MDGs have that: “Significant progress has also been achieved with regard to education, with the primary school net enrolment rate in the developing regions reaching 91% in 2015, up from 83% in 2000” (WHO, 2015b, p. 6).

Public policies implemented from the SUS implementation, such as the Programa de Saúde da Família (1994), Programa Fome Zero (2003), Bolsa Família (2004), Brasil Sorridente (2004), Programa Farmácia Popular (2004), Programa Saúde na Escola (2007), Política de Alimentação e Nutrição (2010), which enabled improvement of social inequality indicators and living conditions, education and health of the Brazilian population.

Due to the still existing social inequality in Brazil, despite progress addressed in this research; equity in health, quality of life, work and financial conditions for all, remain targets for improvement; although Brazil has been presenting favorable results regarding the growth of DHI and poverty reduction from 1990 to 2014 (UNITED NATIONS IN BRAZIL, 2015b).

5. Conclusions

We concluded that there was an improvement in the indicators of living conditions, education social inequality and health of the population in Brazil in 2010.

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Table 1 – Comparative analysis, and significance level of social-environmental indicators of the Brazilian capitals in 2000 and 2010.

Variable	Year	N	Average	Standard deviation	Minimum	1st quartile	Median	3rd quartile	Maximum	P*-value
Gini Index	2000	27	0,62	0,03	0,56	0,60	0,62	0,64	0,67	<0,01
	2010	27	0,60	0,03	0,54	0,58	0,61	0,62	0,68	
Unemployment rate - 25 to 29 years	2000	27	16,89	4,03	10,73	13,27	15,57	20,97	23,66	<0,01
	2010	27	9,70	3,24	4,99	6,87	8,86	12,73	15,87	
% Of employed persons with completed higher education - 18 years or more	2000	27	13,14	5,10	5,93	8,53	12,26	17,04	23,17	<0,01
	2010	27	20,34	5,60	12,46	15,91	20,57	23,95	34,73	
% Of the population in households with bathroom and piped water	2000	27	83,75	14,19	47,25	73,34	90,34	95,19	97,57	<0,01
	2010	27	91,60	9,32	62,10	89,20	95,16	97,39	99,29	
% Of the population in households with garbage collection	2000	27	94,32	5,61	75,92	91,51	95,93	98,74	99,57	<0,01
	2010	27	98,29	1,65	92,95	97,67	98,75	99,64	99,92	
% Of the population in households with electricity	2000	27	99,34	0,94	95,99	99,01	99,70	99,88	99,96	<0,01
	2010	27	99,78	0,36	98,20	99,81	99,90	99,96	99,98	
% Of children aged 0 to 5 years out of school	2000	27	69,78	8,77	51,34	63,06	68,58	79,24	84,90	<0,01
	2010	27	53,89	9,16	33,00	48,00	52,00	59,00	72,00	
% Of children	2000	27	5,29	2,14	3,10	3,95	4,66	5,36	10,64	<0,01

Variable	Year	N	Average	Standard deviation	Minimum	1st quartile	Median	3rd quartile	Maximum	P*-value
	2010	27	3,44	1,14	1,63	2,43	3,37	4,15	5,84	
Life expectancy at birth	2000	27	70,24	2,17	65,03	68,62	70,21	72,03	74,35	<0,01
	2010	27	75,03	1,18	72,85	74,22	74,89	76,28	77,35	
Child mortality	2000	27	27,48	7,11	16,04	21,83	26,45	32,67	43,69	<0,01
	2010	27	14,94	2,50	10,81	13,11	15,28	16,06	22,02	
DHI	2000	27	0,67	0,05	0,58	0,64	0,66	0,73	0,77	<0,01
	2010	27	0,78	0,04	0,72	0,75	0,77	0,81	0,85	
DHI longevity	2000	27	0,75	0,04	0,67	0,73	0,75	0,78	0,82	<0,01
	2010	27	0,83	0,02	0,80	0,82	0,83	0,86	0,87	
Dependency ratio	2000	27	50,53	6,58	42,01	45,57	49,81	52,62	66,82	<0,01
	2010	27	41,63	4,26	34,08	39,13	41,06	42,61	53,07	
Aging rate	2000	27	4,79	1,70	1,58	3,67	4,69	5,58	9,11	<0,01
	2010	27	6,25	2,03	2,73	4,97	6,30	7,54	10,47	
Illiteracy rate - 11 to 14 years	2000	27	3,52	2,30	0,99	1,61	2,75	5,22	10,74	<0,01
	2010	27	2,21	1,13	0,88	1,41	1,85	2,79	5,89	
Illiteracy rate - 25 years or more	2000	27	9,89	4,56	4,06	6,03	8,18	12,69	19,86	<0,01
	2010	27	6,31	3,21	2,47	3,74	5,02	8,49	14,43	
% 18 to 24 years, with completed elementary school	2000	27	64,34	7,98	47,56	58,90	64,30	71,03	78,35	<0,01
	2010	27	81,34	4,31	72,19	78,36	81,71	84,47	90,18	
% 18 to 24 years, with completed high school	2000	27	36,79	8,76	23,42	29,48	34,85	43,72	54,93	<0,01
	2010	27	57,03	6,04	48,47	53,18	56,84	60,60	71,08	
% 25 years or more with completed higher education	2000	27	11,53	4,70	5,36	7,16	10,83	15,29	21,84	<0,01
	2010	27	18,60	5,68	10,97	14,06	18,61	21,26	31,86	
Per capita income	2000	27	833,47	304,30	498,40	592,60	700,81	1187,08	1399,50	<0,01
	2010	27	1148,91	371,32	717,88	805,36	1052,03	1497,29	1866,58	
% Of extremely poor	2000	27	6,30	3,81	1,10	2,38	6,59	9,02	13,02	<0,01
	2010	27	2,69	1,79	0,27	0,92	2,92	4,44	5,89	
% Of vulnerable to poverty	2000	27	39,36	13,33	15,40	25,81	44,87	50,89	58,56	<0,01
	2010	27	24,43	10,31	6,42	14,69	29,16	33,26	39,10	

* Wilcoxon test for paired samples.

Evaluating field exercise courses in the Graduate Program in Sustainability Science, The University of Tokyo

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Abstract

The growing number of educational programs in sustainability goes hand in hand with an increasing number of ad-hoc evaluation schemes that recognize the particularities of this emerging field. While no consensus on the evaluation of graduate programs in sustainability science exists, Wiek's (2013) proposal of five key competencies for sustainability researchers provide a potential framework of evaluation. The following study is the result of student efforts at the Graduate Program in Sustainability Science Global Leadership Initiative (GPSS-GLI) at The University of Tokyo to assess the effectiveness of GPSS-GLI field exercises in developing key competencies for scholars of sustainability. Field exercises are central to GPSS-GLI as educational mechanisms to broaden student perspectives and to cultivate an applied competence to identify and resolve problems in sustainability, which makes the competencies framework based on a research and problem-solving context appropriate for the graduate program. Although each field exercise has its own set of research and educational objectives, the authors focused on how effectively they promoted the competencies suggested as key to sustainability: systems thinking competence, anticipatory competence, normative competence, strategic competence and interpersonal competence. The evaluation was conducted through a participant workshop for each of the 6 field exercise units. The authors moderated the workshops and introduced participants to the objective and evaluative framework of the assessment. Participants were guided through a review of the objective and activities (before, during and after fieldwork) of their unit and a discussion on linkages between the field activities and the competencies they developed. At the end, each participant was requested to complete a questionnaire evaluating how effective the unit was in promoting each competence for themselves. The questionnaire had 15 items and space for comments, with a 5-point Likert scale for active learning, passive learning and recognition of the importance of the respective competence for sustainability of each of five competencies. Results show an overall evaluation of field exercises as at least "satisfactory" (score of 3 or higher) in promoting each of the key competencies. However, results are not consistent across units, with some units yielding more balanced evaluations and others indicating more specialized foci on certain competencies. Further, standard deviation of scores across individuals varies across units and types of learning. In general, units scored lower in passive learning and higher in the recognition of the importance of the competencies. Interpersonal competence scored high relative to other competencies. Overall, results suggest that students are satisfied with how the units help them develop their own competencies. The authors believe this study was a successful attempt at evaluating the educational outcomes of field exercises in a graduate program in sustainability. Students recognized the competencies as important for sustainability science after participating in the units. However, improvements and further research is needed to address aspects such as leadership that have not yet been considered.

Keywords: Sustainability, Evaluation, Field exercise, Competencies, Sustainability education

1. Introduction

Sustainability science has been promoted actively both in research and education as a vibrant response to the emerging sustainability challenges such as climate change, environmental degradation, food security, energy, and increasing inequality. The main disciplinary foci of sustainability science are in understanding the complex interactions between natural and social systems (Anderies, Janssen, & Ostrom, 2004; Clark & Dickson, 2003; Robert W Kates et al., 2001; Komiyama & Takeuchi, 2006; Ostrom, Janssen, & Anderies, 2007), and knowledge contribution for achieving sustainable development (Griggs et al., 2013; Robert W Kates & Parris, 2003; Martens, 2007; Parris & Kates, 2003). Since these sustainability challenges often require action orientation to address the status quo, the discipline deploys problem-based and solution-oriented approaches (Clark, 2007; Miller et al., 2014; Spangenberg, 2011). Reflecting this problem-driven stance, sustainability science combines an interdisciplinary approach that employs diverse academic knowledge including natural science, social science, and humanities, with a transdisciplinary approach, which promotes co-design and co-creation of knowledge to address real-world sustainability challenges with diverse social stakeholders (Bettencourt & Kaur, 2011; Brandt et al., 2013; Trencher, Yarime, McCormick, Doll, & Kraines, 2013; Wiek, Farioli, Fukushi, & Yarime, 2012).

Along with the establishment of sustainability science field by those seminal literatures, sustainability-related education programs are promoted. According to the list of SSPP (Sustainability: Science, Practice, & Policy)20, currently, there are more than 230 sustainability programs at university level in the world (SSPP, 2016). The majority of them are located in either the North American countries (the United States and Canada) or European countries (Sweden, Switzerland, Germany, and United Kingdom). Additionally, there are few other sustainability science programs growing firmly in other parts of the world such as postgraduate programs on sustainable development at Sustainability Institute, Stellenbosch University (South Africa), and Master's and Doctorate degree programs at Graduate Program in Sustainability Science (GPSS) at The University of Tokyo (Japan).

While the research dimension of sustainability science has started to form its own distinct space and landscape within academia (Clark, 2007; Kajikawa, Ohno, Takeda, Matsushima, & Komiyama, 2007; Kajikawa, 2008; R. W. Kates, 2011), the education dimension of the discipline is still under development. In fact, many of the existing sustainability programs are under another disciplinary department or program, commonly within Environmental Studies, Engineering, and Development Studies. By having inter-/trans-disciplinary approach as its core orientation, it is challenging for the program coordinators to design a sustainability science educational program as it needs to accommodate diverse knowledge and skill provisions to students within one academic program. At the same time, how to provide the education on the action-oriented manner of sustainability science is another key challenge.

Since sustainability science is a new academic discipline, the amount of literature on its education is limited. Among the few previous studies, some program designs and applied methodologies in sustainability science are discussed (Mino et al., 2016; Onuki & Mino, 2009; Tamura & Uegaki, 2012). In terms of the required competencies for students in sustainability science programs, Wiek and his colleagues provides a comprehensive discussion (Wiek, Withycombe, & Redman, 2011). Additionally, their following study addressed the discussion of program evaluation through the case study on the Seed Sustainability initiative at ETH Zurich (Brundiers & Wiek, 2011). Yet, in general, there are further needs of research on pedagogy and evaluation in sustainability science programs.

This study focuses on the problem-driven approach of sustainability science in educational context with the case study of Graduate Program in Sustainability Science (GPSS) at The University of Tokyo. GPSS offers fieldwork-based training courses to provide opportunities to experience the real-world problems and design research approaches with specific topical cases. While such case-based education is becoming common, there is an increasing need for developing a robust

[20] SPSS is one of the peer-review, open-access journals which focuses on sustainability science research. The journal also provides an international network of sustainability research and education.

evaluation scheme to examine its learning effectiveness. By reviewing six field-based courses at GPSS, this study aims to contribute to the evaluation discussion of sustainability science programs.

2. Methods

The assessment began with an initial phase for the development of its conceptual framework and methodology, followed by more systematic implementation according to the resulting methodology. The first phase took place in the Tohoku Resilience Exercise, one of six workshops so far assessed. While the exercise itself had an educational focus of having students grapple with the complexity of issues surrounding the regional reconstruction after the Tohoku Earthquake and Tsunami of March 2011, students simultaneously engaged in a rigorous reflexive analysis that laid the foundation of this assessment effort (San Carlos et al., in press_a).

This initial phase of development began with a review and analysis of Wiek's (2011) conceptual framework of key competencies for sustainability science research that had been used in a previous assessment of the said program in Tumilba et. al (2013). Due to the characteristic focus on real-world problem training in GPSS-GLI, the chosen framework was deemed appropriate since the five key competencies are all tied up to the context of a research and problem-solving framework (Wiek et. al, 2011; San Carlos et. al, in press_a). Collectively, students reviewed the existing Wiek's (2011) existing framework and adapted the original definitions for use within an educational context (Table 1). The group then self-analysed the linkages of each of these competencies with the activities and issues within the Resilience Exercise. The need to distinguish between active and passive learning, as well as the recognition of the importance of the competence to one's role as a scholar in sustainability science arose from the process. As discussed by San Carlos and colleagues (in press_a), a review of academic literature revealed a lack of consensus and clarity on the definitions of active and passive learning (Bonwell & Eison, 1991; Chi, 2009). For practical purposes, our understanding is that active learning involves active engagement, while as passive learning may occur through transmission of information through lectures and other methodologies that do not require student engagement (San Carlos et al., in press_a). At the end of the week-long Exercise unit with daily discussions, students individually filled out questionnaires designed based on these principles to allow quantification for subsequent analysis.

The questionnaire, designed as follows, was maintained for use throughout this assessment project. Though based on the assumption that the respondent would have received some explanation of the competencies, definitions were listed as shown on Table 1. Students were to rate the unit's effectiveness in facilitating the personal development of the respective competence beyond their baseline level. The evaluation for each competence was threefold, one for passive learning, one for active learning, and another for "recogni(tion)/agree(ment) about the importance of the competence for research of sustainability issues" (hereafter: "Recognition"). Responses were indicated according to a 5 point-Likert scale (1: very ineffective (no influence); 2: ineffective, 3: satisfactory, 4: effective, 5: very effective). Open space was provided at the end of the questionnaire with prompts to comment freely on their own experiences or provide feedback on the assessment itself.

All subsequent evaluations were conducted after the completion of the field exercise courses, and followed the following procedure. The authors contacted student participants of a respective unit through e-mail and/or social media in order to schedule a workshop. This correspondence involved all student members from GPSS-GLI, with one exception where the student had already graduated and left the country. In most cases, workshops involved the full student group of the unit. At the workshop, facilitated by at least one of the authors began with a brief introduction of the assessment project, then inquired about the unit's educational and/or research objectives. Using a whiteboard or screen projection, the students were then asked to list out the units' activities. The competencies framework was then introduced using the definitions on Table 1, and students were asked to identify any linkages between the respective competencies and the listed activities. At the end, the questionnaire was handed out either electronically or on paper for students to complete individually. The total duration of the workshops was about 90 minutes in average, and all workshops were conducted between September and November 2015.

In addition to the above processes, consultations with faculty and affiliated staff members are in progress as a means to consider the appropriateness of the completed assessment. To date, this process has consisted of an e-mail consisting of a semi-structured questionnaire with faculty and staff members associated with each field exercise course. All respondents were e-mailed a summary of the results including the respective unit and cross-unit averages, as well as a document outlining the intent of the assessment and prompts for responses regarding 1) explanations and interpretations of the results; 2) reflections on the exercise design; comments and feedback on the assessment itself. As some unit-specific comments would be traceable to individual faculty members, the document asked faculty members to indicate their willingness to have their comments attributable to the unit in question.

Table 35. Original and interpreted definitions of Key Competencies in Sustainability (adapted from San Carlos et al., in press_a)

Competence	Definition (Wiek, 2011)	Interpretation used
Systems-thinking competence	"An ability to collectively analyse complex systems across different domains (society, environment, economy, etc.) and across different scales (local to global)..."	An ability to systematically analyse interconnected issues of the reconstruction process (e.g. coastal structures, fishery industry, aging society, housing reconstruction) and categorize them across different domains (social, environmental, economic) and scales (individual, community, town, prefecture)
Anticipatory competence	"An ability to collectively analyse, evaluate, and craft rich "pictures" of the future related to sustainability issues and sustainability problem-solving frameworks"	An ability to envision, analyse and evaluate possible outcomes of different approaches to reconstruction process
Normative competence	"An ability to collectively map, specify, apply, reconcile, and negotiate sustainability values, principles, goals, and targets"	An ability to recognize and analyse different values that guide the decision making process of individuals and groups of people regarding reconstruction process. An ability to take a normative standpoint when participating in decision-making process within a group.
Strategic competence	"Ability to collectively design and implement interventions, transitions, and transformative governance strategies toward sustainability"	An ability to design and implement strategies for reconstruction process
Interpersonal competence	"An ability to motivate, enable, and facilitate collaborative and participatory sustainability research and problem solving "	An ability to contact, approach and communicate with various stakeholders in the field involved in reconstruction process. An ability to work before, in and after the field in a multinational group of students and faculty.

3. Results

Student workshop and faculty participation rate

As shown in Table 2, the assessment had a high rate of participation, with 100% participation in four out of six units. Email inquiries with faculty and staff members were followed up with reminders and reached a response rate of 86% (*n*=7). As only one staff member was contacted, faculty and staff will hereafter be referred to as “respondents” to ensure confidentiality.

Table 36. Assessment workshop participation rate

Unit	# of GPSS students in unit	# Participants in Workshop	Participation Rate
Minamata	10	8	80%
Tohoku	8	8	100%
Oasis	5	5	100%
Costa Rica	5	5	100%
Bangkok	3	3	100%
Nairobi	8	7	88%

Student workshop and questionnaire results

Table 3 shows the questionnaire results. Columns (A) to (F) show results in each field exercise course by competence. Rows (1) to (5) show the results for each competence by field exercise course. Mean scores and standard deviations (SD) for each competence are shown by type of learning. The last column and row represent the aggregate means by competence and unit, respectively.

Table 3. Questionnaire results

Results and discussion by competence and type of learning

Figure 1 shows the mean scores for the five competencies by type of learning. The minimum value for the v[illegible] re[illegible]ces of scores among competen[illegible] d [illegible]ercise courses, as all five com[illegible] a[illegible] types of learning. The highest scoring competence was Interpersonal Competence (M=4.17), while the lowest scoring competence was Strategic Competence (M=3.38).

Competence	Type of learning	MINAMATA (A) Unit Score	MINAMATA (A) SD	MINAMATA (A) Unit Score (Average)	TOHOKU (B) Unit Score	TOHOKU (B) SD	TOHOKU (B) Unit Score (Average)	OASIS (C) Unit Score	OASIS (C) SD	OASIS (C) Unit Score (Average)	COSTA RICA (D) Unit Score	COSTA RICA (D) SD	COSTA RICA (D) Unit Score (Average)	BANGKOK (E) Unit Score	BANGKOK (E) SD	BANGKOK (E) Unit Score (Average)	AFRICA (F) Unit Score	AFRICA (F) SD	AFRICA (F) Unit Score (Average)	OVERALL COMPETENCIES (G) Unit Score	OVERALL COMPETENCIES (G) Unit Score (Average)
(1) SYSTEMS THINKING COMPETENCE	Passive Learning	3.75	0.89	3.88	3.88	1.13	3.55	4.20	0.84	4.40	3.40	1.14	3.80	4.00	0.82	3.78	3.71	0.95	3.86	3.82	3.88
	Active Learning	4.00	1.07		3.38	1.30		4.60	0.55		4.20	0.84		3.67	1.25		3.86	0.90		3.95	
	Recognizing the importance of the competence for solving sustainability issues	3.88	0.64		3.38	1.41		4.40	0.89		3.80	1.10		3.67	0.47		4.00	0.58		3.86	
(2) ANTICIPATORY COMPETENCE	Passive Learning	3.25	1.04	3.46	3.63	1.19	3.67	3.40	0.55	3.67	3.20	0.84	3.20	3.67	0.47	3.78	3.00	1.15	3.57	3.36	3.56
	Active Learning	3.38	0.92		3.38	0.74		3.20	1.64		3.00	0.71		4.00	0.82		3.57	1.27		3.42	
	Recognizing the importance of the competence for solving sustainability issues	3.75	1.04		4.00	1.41		4.40	0.89		3.40	0.55		3.67	0.47		4.14	0.90		3.89	
(3) NORMATIVE COMPETENCE	Passive Learning	3.88	0.64	3.92	3.75	0.89	3.54	3.20	0.84	3.47	3.00	1.41	3.53	3.67	0.94	3.67	3.29	1.25	3.72	3.47	3.64
	Active Learning	3.63	0.52		3.00	1.31		3.40	0.89		3.80	0.84		4.00	0.00		3.57	1.27		3.57	
	Recognizing the importance of the competence for solving sustainability issues	4.25	0.71		3.88	1.36		3.80	1.30		3.80	1.30		3.33	0.47		4.29	0.76		3.89	
(4) STRATEGIC COMPETENCE	Passive Learning	3.25	1.04	3.63	3.13	1.13	2.75	2.20	1.30	2.40	3.60	0.89	3.87	3.67	0.47	4.00	3.14	1.07	3.62	3.17	3.38
	Active Learning	4.00	0.93		1.63	0.52		2.00	1.22		4.00	1.00		4.00	0.82		3.43	1.40		3.18	
	Recognizing the importance of the competence for solving sustainability issues	3.63	0.92		3.50	1.51		3.00	1.58		4.00	0.71		4.33	0.47		4.29	0.76		3.79	
(5) INTERPERSONAL COMPETENCE	Passive Learning	3.75	1.04	4.04	3.50	1.20	3.79	4.60	0.55	4.87	4.00	1.22	4.20	4.00	0.82	4.00	3.57	1.62	4.09	3.90	4.17
	Active Learning	4.25	0.71		4.00	1.07		5.00	0.00		4.40	0.55		4.33	0.47		4.00	1.15		4.33	
	Recognizing the importance of the competence for solving sustainability issues	4.13	0.83		3.88	1.36		5.00	0.00		4.20	0.84		3.67	0.47		4.71	0.76		4.27	
OVERALL GFE/RE (AVERAGE)				3.79			3.46			3.76			3.72			3.85			3.77		3.73

Assessment of the effectiveness of this exercise for facilitating the following competences.

Score	1.00	2.00	3.00	4.00	5.00
	Very ineffective	Ineffective	Satisfactory	Effective	Very effective

- Score equal or higher than average score for that competency overall GFE/RE
- Score lower than average score for that competency overall GFE/RE
- Standard Deviation higher than 1 point (within the 5 point Likert scale)

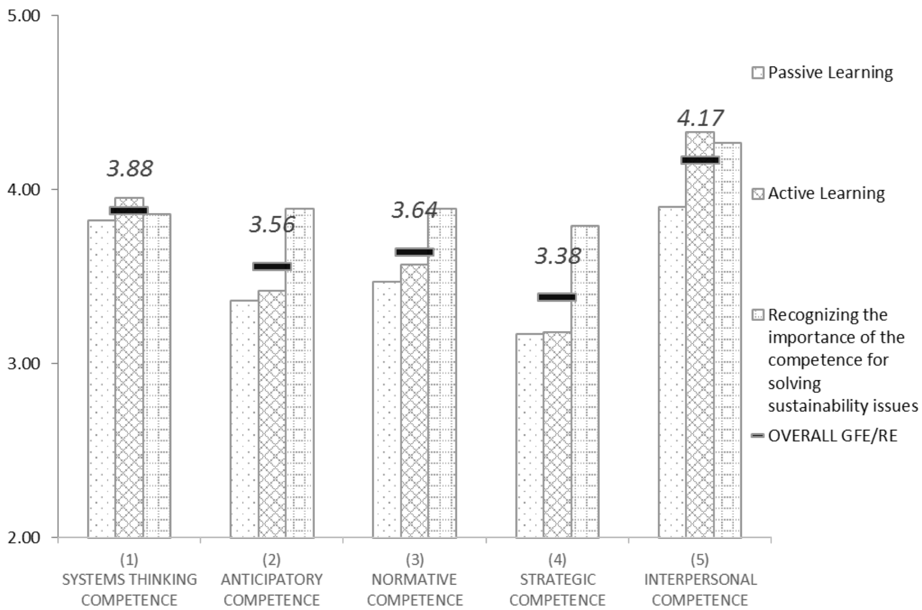

Figure 14. Aggregate scores by competence and type of learning

High scores on Recognition indicate that students generally agreed with Wiek (2011) on the relevance of the respective key competence for sustainability science research. Recognition scored higher than the other types of learning on four of five competencies (Anticipatory Competence (M=3.89); Normative Competence (M=3.89); Strategic Competence (M=3.79); Interpersonal Competence (M=4.27)). Regarding Systems Thinking competence, Recognition only scored marginally below the mean score of 3.88 (M=3.86).

Active Learning consistently scored higher than Passive Learning for all competencies. This is intuitive, as the Exercise courses are based on the concept of providing opportunities for active engagement in the field (GPSS-GLI, n.d.). The difference was greatest for Interpersonal Competence, where the aggregate mean for Active Learning (M=4.33) was 0.43 points greater than for Passive Learning (M=3.90). In contrast, this gap between Passive (M=3.17) and Active (M=3.18) Learning was only 0.01 for Strategic Competence.

Other notable results are the high scores on Interpersonal Competence (M=4.17) and low scores on Strategic Competence (M=3.38). Effectiveness with the development of Interpersonal Competence may be explained by the fact that GPSS-GLI is highly diverse in terms of cultural, academic, and professional backgrounds as well as demographics (GPSS-GLI, n.d.). Lower evaluations on Strategic Competence may be due to the expectation and desire of students to have a tangible impact of the study area, although time and resource constraints limit such impact in reality. Both student and faculty respondents commented that courses focused on understanding past and current situations rather than on speculating over future prospects. This is understandable given the one to two week duration of the courses and consistent with the interpretation regarding the lack of capacity of the courses to have tangible impact.

Results and discussion by field exercise course and competence

Figure 2 shows competence and mean scores for the six field exercise courses assessed in this study. Again, the minimum value for the vertical axis is set at the score of 2.0 to highlight differences across units. Mean scores by field exercise course were also higher than satisfactory (3.0). The highest scoring field exercise course was the Bangkok Unit (M=3.85). The Tohoku Unit (M=3.46) scored the lowest and with high inter-student variation in each competence, a result likely attributable to the extended and critical discussions specific to this unit (San Carlos, in press_a).

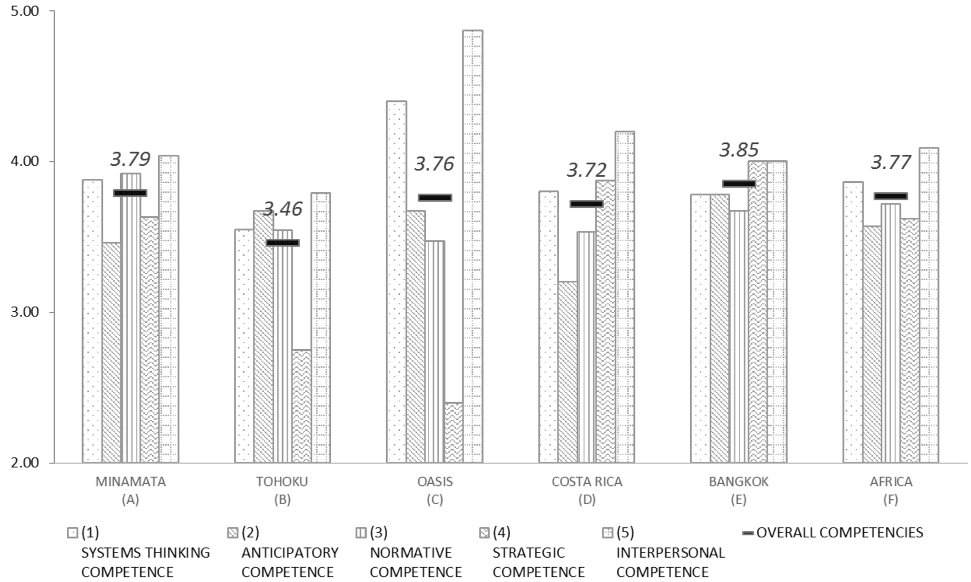

Figure 15. Aggregate score by unit and competence

Results showed varying tendencies across units on scores and standard deviations. Minamata Unit consistently obtained high scores and low standard deviations for all competencies (see Table 1, column (A)). Tohoku Unit yielded the lowest mean score (M=3.46), with similar results excepting Strategic competence (M=2.75), which scored below "satisfactory." However, standard deviations within each competence were high for all competencies and almost all types of learning (see Table 2, column (B)). The contrast between Minamata and Tohoku Units was highlighted as particularly interesting by one of the respondents "although both are designed as "experience-oriented" unit under similar concepts of unit design".

The Oasis and Costa Rica units were similar in their focus on research. However, evaluations by Oasis Unit students had large variation (e.g. standard deviations above 1.0 for Strategic competence (Passive (SD=1.30); Active (SD=1.22); Recognition (SD=1.58))). Students in both units were consistent in their high evaluations of the course's impact on their Interpersonal Competence (Oasis (M=4.87); Costa Rica (M=4.20); see Table 2, columns (C and D)). In particular, Oasis student evaluations for Interpersonal Competence was highest of all units (aggregate M=4.87). This outcome may be attributed to the emphasis on student leadership noted by the faculty respondents affiliated with the respective units. One of these respondent stated that this emphasis may have been interpreted as a lack of strategic vision in the design of the unit, explaining the lower results for Strategic competence.

General scoring patterns on the Bangkok and Africa Units are comparable, however with higher internal consistency in the former course unit (see Table 2, column (E, F) and Figure 2). Africa Unit yielded relatively high variation amongst students for Passive and Active Learning. An affiliated respondent observed that these relatively high variations might indicate that "the exercise led to variable experiences for different students." Another respondent affiliated with the Bangkok Unit expressed surprise at the lower scores on Recognition. Regarding Systems Thinking competence, this respondent suggested that more attention should be given to a "holistic view about the complex systems (economic, social etc.) relating to the environmental and health issues" present in the unit.

4. Discussion

This student-led assessment of field exercise courses in GPSS-GLI, a graduate program on sustainability science, addresses needs of the program in question as well as of the existing body of academic literature in search for the relevant competences for sustainability science research and their assessment (Wiek et. al, 2011; Barth et al. 2007; Tumilba et al., 2013). Regarding the program, the present study follows from an initial assessment conducted six years after the formulation of the program (Tumilba et al., 2013). The initial assessment explored student perspectives on GPSS-GLI activities and the development of their competencies. This study builds on this foundation with a more detailed and in-depth assessment of field exercise courses, a core activity in the program.

Contributions to GPSS-GLI

Use of student self-evaluations follows from the previous method of assessment (Tumilba et al., 2013). Furthermore, student participation in the assessment and development of GPSS-GLI is consistent with the program's emphasis on developing student leadership skills (GPSS-GLI, 2016).

Responses on the validity of the assessment are mixed, yet overall positive. Most faculty members considered the competence framework to be appropriate to the context of GPSS-GLI, and five out of six faculty consulted considered the results to be insightful to varying degrees. Comments included, "the results seem accurate," and "results are convincing."

Nonetheless, some comments were skeptical of the framework and/or fundamental approach of this assessment. One respondent considered the competence framework to be unfit for this assessment, another did not understand the framework enough to evaluate it, and a third considered it necessary to differentiate between the two types of field exercise courses (Global Field Exercise and Resilience Exercise) offered. A further response questions, "overall assessment has to be looked at with a question mark."

Methodological limitations

Indeed, limitations to this ongoing assessment must be carefully considered. First, a retrospective assessment could make it difficult for students to relate their experiences on the field to the development of their competencies, and the time between the exercise course and assessment varied from unit to unit. Second, evaluations depend on student comprehension of the competencies in question, and the relatively short workshops may have been insufficient to ensure adequate comprehension. One faculty member raised this issue and recommended the inclusion of the competencies in the guidance given before each field exercise course.

Third, scores reflect what students considered to be the additional improvement of their competencies due to the field exercise courses. Accordingly, results are subject to variations in baseline levels. Individual experiences before, during and after the units play a great role in student assessment, and a respondent questioned "if [students] could really assess what outcome/impact they experienced for each key competence and by how much accurately."

Fourth, the exercise courses were designed with unique objectives, none of which explicitly involved the said competencies. However, according to a comment from a faculty member in relation to the design of one of the units the "assessment results show that this design was vindicated", somewhat validating the methodology even if differed from the original design. A higher or lower score is not necessarily positive or negative, but a mere reflection of the unit design, and results ought to be viewed in light of each unit. Alternatively, future assessments should consider how to incorporate or reflect the design of the respective unit in the assessment framework itself to sufficiently assess field exercise courses that were not necessarily created with the same objectives in mind.

For example, intended objectives of the respective course unit may be integrated into the assessment framework to provide insights more fitting for the unit in question. However, condensing the main features of each unit design into the assessment framework would be extremely challenging. Instead, the authors believe that a post-assessment discussion with students and faculty could shed light on the results obtained and allow for an open discussion that would involve the units' design.

Additionally, more qualitative data on students' experience could offer a deeper insight into the results and how the competencies were developed in each unit. One respondent suggested "one would have to have qualitative expressions about their experiences" in order to better analyze the assessment outcome.

Fundamental considerations

Finally, this competence based assessment of an educational program calls for a careful and fundamental reconsideration of the application of such a framework in this context. Within the program, faculty members must consider the appropriateness of the applied framework in this assessment, as well as whether or not and how to incorporate the outcomes into the design of future course units.

While Wiek's (2011) framework was selected for its specific focus on sustainability science, Wiek himself specifies that pedagogy was beyond the scope of his study. Thus, the application of his framework to education is so far unique to this assessment project (Tumilba et al., 2013; San Carlos et al., in press_a), and consideration must be made. For example, universal competencies, other than those "key" to sustainability science have not been considered, and the list of five so far identified has yet to be finalized (Wiek, 2011). Further, alternative approaches to assessment such as the Integral Framework, employed by a GPSS-GLI faculty member in the design of a course unit (Akiyama and Li, 2013; San Carlos et. al, in press_b), or those focusing on affecting learning outcomes (Shepard, 2007) were beyond the scope of the present study but must be taken into consideration.

More fundamentally, objective and validity of an assessment need to be carefully examined. Most faculty members consulted in the assessment consider development of evaluation scheme for sustainability science education an important task and necessary for better design of courses. However at the same time, there was a shared concern among the respondents that an emphasis on assessment development may lead them to worry that program activities are designed "evaluation-based" excessively.

5. Conclusions

It is expected that in the future new developments of program assessment will incorporate and address identified limitations of this study. In particular, the conceptualization of the assessment framework to include and reflect the diversity among the field exercises needs to be carefully analysed. In terms of implementation, attention needs to be paid to standardizing the concepts used and the common understanding among students and faculty of the methods and terminology. There should also be agreement within the graduate program regarding the role and relevance that the assessment will play and the effort willing to dedicate to this task.

Although the framework utilised differs from the design of each individual field exercise, the results showed enough evidence to support the usefulness and appropriateness of the assessment. The authors considered the present study a successful and relevant step forward in the assessment of field exercise courses in the Graduate Program in Sustainability Science of The University of Tokyo, and a contribution to the general discussion regarding the assessment of key competencies for sustainability science research.

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A characterisation of the academic profile of a community of professors involved in Sustainable Human Development: the case of the Global Dimension in Engineering Education

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Abstract

In the last decade, a number of technical universities and engineering faculties have been engaged in different initiatives aimed at integrating sustainable development in their functions. Academic staff engagement in sustainable development issues has been recognised to be a catalyst in curriculum change processes. This contribution presents and discusses key findings from a research conducted on academics involved in training activities related to Sustainable Human Development in the framework of the European initiative “Global Dimension in Engineering Education – GDEE”. This initiative aims at promoting the integration of Sustainable Human Development as cross-cutting issue in teaching activities of technical universities, mainly by improving the competencies of academic staff, and through staff engagement in a wide range of initiatives related to Sustainable Human Development. A number of academics, mostly engineers and lecturers from European technical universities, have been involved in different activities of the project: elaboration of training materials, delivery, coordination and evaluation of on-line courses, development of case studies and attendance of courses. The present study analyses and characterises the academic profile of two groups of academics, with different grade of expertise and involvement in Sustainable Human Development, with the aim to enhance the understanding of the academic profile of faculty engaged these topics, and fostering the replicability of similar initiatives in different contexts. From one side, a group of experts that have contributed in developing training materials and on-line courses. From the other side, a group of participants to training activities, namely academics of engineering or science-based universities that completed one or more courses offered through the Spanish virtual platform. The methodology includes i) a bibliometric analysis of the scientific publications of the two groups, and ii) an analysis of a semi-structured questionnaire focused on academic activities and social outreach of this collective. The results provide an in-deep characterization of this community, highlighting trends and similarities of the academic activities and the scientific production of this collective. The analysis also highlighted that academics involved in this project present research and teaching activities strongly integrated and with positive mutual feedback, as well as relevant linkages with civil society and non-governmental organisations. Based on these findings, the paper concludes suggesting a specific profile of trainers to successfully promote initiatives similar to GDEE in other contexts and proposing the implementation of more appropriate policies and mechanisms, at university level, to recognize the efforts of academics engaged in issues related to Sustainable Human Development.

Keywords: Global Dimension, Engineering, Sustainable Human Development, Sustainable Development Goals, Higher Education Policy.

1. Introduction

The last decades have witnessed an increased political will in relation to global Sustainable Development (SD), which has been identified as one of the greatest challenges that our societies are facing. This process of growing social recognition has guided the Post-2015 Development Agenda leading to the final adoption of the Sustainable Development Goals (SDG) (United Nations, 2015). In response to this growing call, an increasing number of higher education institutions (HEI) have been engaged incorporating SD into their systems (Lozano et al., 2014), reconsidering the content of their curricula. Nonetheless, many challenges remain. Scientific literature identifies multiple barriers preventing a proper integration of SD into higher education (Velazquez et al. 2006; Lozano 2006). These barriers have been related to: i) lack of awareness or interest in SD issues of academics, students and staff; ii) the structure of higher education, characterised to be conservative and disciplinary with strong resistance to change of the functions of education and research; and iii) lack of resources and adequate institutional support (Verhulst and Lambrechts, 2014).

These issues are particularly sensitive in technical universities where education is primarily focused on the technical and, traditionally, there have not been many opportunity to develop broader knowledge and skills to respond to the complexity of global problems related to SD (Crofton, 2000). Currently, engineering methods and tools are still characterised by a strong practical orientation and are mostly focused at finding and implementing solutions that work with certainty and predictability (Halbe et al., 2015).

In this environment, characterised by technical paradigms and a strong disciplinarity, it is not an easy task promoting a cultural shift to existing dominant structures and practices to integrate SD values into curricula. For these reasons, few engineering schools seems to have made major updates to their courses and curricula over the past few decades (Davidson et al., 2010). Responses to the calls of curricula reform in engineering are, in general, relatively limited (Fenner et al., 2005; Lozano and Lozano, 2014; von Blottnitz et al., 2015), and much of the efforts are mostly focused in developing individual courses on SD (von Blottnitz et al., 2015). Different approaches have been focused specifically on technical universities (Boni and Pérez-Foguet, 2008; Lozano et al., 2014; Pérez-Foguet et al., 2005; Segalàs et al., 2010). Furthermore, other efforts have aimed at reinforcing the alignment between engineering and development studies (Boni and Pérez-Foguet, 2008; Pérez-Foguet et al., 2005), in line with Sustainable Human Development (SHD) theoretical framework (Absell, 2015) .

It is worth highlighting that in HEI often there is no adequate institutional support and incentives for those academics willing to integrate SD in their teaching and research activities (Hoover and Harder, 2014), and most of the efforts lie primarily in personal satisfaction of overcommitted academics and remain mostly unrewarded (Krizek et al. 2012). In the case of engineering, activities not falling within the disciplinary context of the core technical content are often not fully recognised during the evaluation of teaching and research merits. Mulder et al. (2012) analysing the education of engineers for SD and its relevant challenges, emphasize the need for complementary approaches to foster changes in engineering curricula. Specifically, they point out that top-down institutional support has to be complemented with bottom up initiatives, aimed at further engaging motivated faculty. It is vital, thus, to effectively tackle this shortcoming, identifying the drivers to foster the empowerment and the active engagement of academics in sustainability education and research.

Having this context in mind, this contribution presents and discusses key findings from a research conducted on professors and researchers involved in academic activities related with SHD in the framework of the European initiative “Global Dimension in Engineering Education” (GDEE). The GDEE initiative is a European network whose aim is to increase the awareness, critical understanding and attitudinal values of undergraduates and postgraduates students in technical universities across Europe related to SHD and its relationship with technology. This has been dealt with by integrating SHD as cross-cutting issue in teaching activities by improving the competences of academics and through engaging both staff and students in initiatives related to SHD. It started in 2012 as a collaborative project between a consortium of European Universities and Non-Government Organisations of Spain, Italy and United Kingdom funded by EuropeAid.

The pedagogical approach, based on previous works of project partners (Boni Aristizábal and Pérez-Foguet, 2006; Oliete-Josa and Pérez-Foguet, 2008), has been described extensively elsewhere (Trimingham et al., n.d.). For the purpose of this research, it is worth mentioning that the project strategy has been based on a continuous professional development approach addressed to academics focused on three main areas: competences, connectivity and collaboration.

1. Competences: enhancing the competences of academics and students with regards to their understanding of SHD issues and their capability to mainstream them in the academic curricula;

2. Connectivity: enhancing the capability of academic institutions to connect and share efforts within and across EU Member States as well as share and disseminate results and best practices regarding the integration of MDGs/SDGs into technology studies;

3. Collaboration: enhancing the ability to work with other stakeholders, notably Non-Governmental Organizations (NGOs) in order to advance a more practical dimension to the work carried out at academic levels.

Through activities related to each one of these three areas the project aimed at fostering a Global Dimension (GD) as an integral part of engineering education. A GD is one that encourages students to think of themselves as global citizens and thus promote a sense of global social responsibility (Bourn & Neal 2008). The focus is on the incorporation of SHD in academic activities, specifically promoting the understanding of issues related to global development: extreme poverty, human rights, globalisation, equality issues and environmental challenges. This approach has already relationships with other agendas, such as: sustainability science, humanitarian engineering and ethics. However, the benefits of including a GD is that it can help students make links to the real world, and enable engineers to play a role in poverty reduction, human rights issues, and conflict resolution. The composition of the consortium, comprising universities and NGOs, reflects the approach promoted with this initiative: fostering the cooperation between NGOs and academia as key factor in reinforcing the presence of SHD in formal teaching programs at all levels of engineering education.

According to this strategy, the project included different complementary activities aimed at up-skilling, motivating and engaging academics with development issues, as well as promoting SHD issues in engineering education. Among main project outcomes, nine on-line courses were developed in order to increase the competences and abilities of academic staff of technical or science-based universities to integrate development-related issues in their teaching and research activities. For the implementation of each course, a set of training materials has been developed by selected European experts in this field. Besides, a set of teaching resources aimed at supporting lecturers at integrating SHD issues in teaching activities were developed. All these resources are available online at the project website (GDEE, 2015) distributed as Open Educational Resources (OER).

At the project completion, in April 2015, the GDEE community comprised more of four hundred members from a total of eighty-four different universities. The network includes different profiles, mostly academics but also non-academics experts in the field of development (from NGOs, development training centres, and engineering organizations). Some of them were directly involved in project's activities; others are participants who attended GDEE on-line courses offered in the three partners' countries; and others are academics or professionals interested in joining the activities of the network. With respect to this research, it is worth mentioning that almost hundred professionals, mostly academics, have closely collaborated in developing training and teaching materials as well as in the delivery, coordination and evaluation of on-line courses. On the other hand, almost three-hundred people, mostly academics, enrolled in one or more for a total of 885 enrolments.

2. Methods

Starting from the context described earlier, this research aims at analysing comparatively and characterising two groups of the GDEE community, in order to enhance the understanding of the academic profile of faculty engaged in SHD issues and, consequently, foster the replicability of the initiative in different contexts.

The two groups analysed have different grades of expertise and involvement in SHD. From one side, 43 contributors, experts in SHD that have closely collaborated in developing training materials as well as in the delivery of on-line courses. From the other side, 47 participants, academics of engineering or science-based Spanish universities that completed one or more courses offered through the Spanish virtual platform.

Methods include: i) a bibliometric analysis of the scientific publications of contributors and participants in order to analyse the scientific profile of the two groups and ii) an analysis of a semi-structured questionnaire aimed at deepening the understanding of the academic profile of faculty involved in activities related with SD.

2.1 Bibliometric analysis

The bibliometric analysis of the two groups of GDEE community includes the following steps:

- Selection and analysis of the research publications registered in Scopus database of the GDEE community.
- Generation of an overlaid journal map based on data download from Scopus
- Operationalization of a disciplinary diversity index.

After comparing the two main scientific databases Web of Science (WoS) and Scopus, following Aghaei Chadegani et al. (2013) we opted to use the latter as our principal data resource mainly because Scopus adapts better to the characteristics of GDEE community. In fact, among GDEE courses participants there are a number of young; professors and PhD students, and Scopus covers a superior number has a broader coverage of journals even if with lower impact. Thus, essential research quality indicators (such as volume, impact, h-index) have been analysed using Scopus database.

After performing author search in Scopus database for each member of the groups of contributors and participants, for a total of 90 entries. We found out that, roughly, only 60% of the members of GDEE community have a Scopus ID, for different reasons. Among contributors, mainly due to a number of NGO practitioners and other experts that do not have research publications. Instead, among courses participants, we found, surprisingly, a significant number of professors without Scopus ID as well as few practitioners and PhD students. Subsequently, we examined the scientific literature of all the members of the GDEE community with Scopus ID (respectively 31 contributors and 22 participants).

Bibliometric analysis can be greatly enriched with the help of appropriate visualisations. Science maps, for example, are suitable tools for this purpose. They are visual representations built on the overall science interrelationship based on journal articles (Leydesdorff et al., 2014; Porter and Rafols, 2009), and help to visually identify major areas of science, their size, similarity and interconnectedness. Specifically, the use of science maps is particularly helpful since allows to analyse different aspects of disciplinarity such as: i) the variety of “disciplines”; ii) the balance, or distribution, of disciplines (expressed by the relative size of nodes in the map); and iii) the disparity, or degree of difference, between the disciplines (expressed by the distance between the nodes of the map) (Porter and Rafols, 2009).

Given the purposes of this study, we opted for a base map tool called Overlay.exe21, a global map of science that can be interactively overlaid with journal distributions in sets downloaded from Scopus. Base maps can be used as a basic framework on which the journal distribution of a set of documents downloaded from Scopus can be projected. Subsequently, it is possible assessing the portfolio of documents in terms of the spread across journal and journal categories.

[21] Overlay.exe is available online at: http://www.leydesdorff.net/scopus_ovl/index.htm . For a complete description of the tool please consult (Leydesdorff et al., 2014)

Furthermore, base maps can be used as a distance maps for measuring interdisciplinarity in term of journal composition (Leydesdorff et al., 2014). Simple to more complex indicators have been developed for the purpose of assessing interdisciplinarity of researchers (Porter et al., 2007). For the purpose of this research we opted for the use of Rao-Stirling index. Unlike other indexes commonly used to assess interdisciplinarity, such as Shannon or Herfindahl, Rao-Stirling accounts not only for the variety but also for also for the disparity, namely the ecological distance among different subsets of journals (Leydesdorff and Rafols, 2011; Porter and Rafols, 2009).

2.2 Semi-structured questionnaire

Contextually to the bibliometric analysis, a survey aimed at deepening the understanding of the academic profile of faculty involved in GDEE activities has been developed. The survey was divided into six categories:

1. Academic profile of the respondents (affiliation, accredited years of teaching and research)
2. Teaching activities: including specific information on subjects imparted by respondents (such as student evaluation and grading criteria) and engagement of respondents in teaching innovation activities.
3. Research activities: including main research fields of respondents, especially focusing on the relation between research and teaching activities.
4. Degree of integration of SDGs in respondents' teaching and research activities, as well as the perceived relation between crosscutting competences adopted by HEI and SDGs.
5. Social outreach and collaboration: entities with which respondents regularly cooperate and the type of collaboration.
6. Perception of the recognition/evaluation of academics merits including university evaluation and regional/national accreditation agencies.

The survey comprised 23 close-ended questions, mostly employing a 5 point Likert scale from 'totally disagree' to 'totally agree', as well as ranking and multiple select questions, which were complemented with 13 open-ended questions to ask respondents a deepening based on their experience on different academic issues. Table 1 shows the survey structure in detail.

Table 1. Survey structure

Academic profile of the respondents	
Professional data	Open-ended questions
Teaching activities	
Subjects imparted	Open-ended questions
Evaluation and grading criteria	Open-ended questions
Engagement in teaching innovation activities	Likert scale; Open-ended questions
Research activities	
UNESCO nomenclature for fields of science and technology	Open-ended questions
Relation between research and teaching	Likert scale; Open-ended questions
Sustainable Development Goals	
Degree of integration of SDGs in teaching and research	Likert scale

Relation between SDGs and university transversal competences	Likert scale
Social outreach and collaboration	
Collaboration with social entities	Likert scale; Multiple-select
Research dissemination channels	Ranking
Perception of the recognition/evaluation of academics merits	
University monitoring of academics activities	Multiple-select
Recognition of academic merits and promotion procedures	Likert scale; Open-ended questions

The aim of the survey was not assessing the engagement of faculty in each specific SDGs but, rather, identify the degree of integration of SDGs concept in respondents' teaching and research activities, specifically those related to engineering. For this reason, SDGs have been grouped in twelve items described in Table 2.

Table 2. Sustainable Development Goals grouping.

Description	SDG
End of poverty and hunger	(SDGs 1, 2)
Ensure healthy lives and well-being	(SDG 3)
Inclusive, equitable and quality education	(SDG 4)
Reduce inequalities and achieve gender equality	(SDGs 5, 10)
Clean water and sanitation	(ODS 6)
Affordable and clean energy	(SDG 7)
Promotion of a decent work and sustainable industrialization	(SDGs 8, 9)
Sustainable cities/communities and sustainable production and consumption patterns	(SDGs 11, 12)
Climate change adaptation	(SDGs 13)
Conservation and sustainable use of ecosystems	(SDGs 14, 15)
Promotion of peace, justice and strong institutions	(SDG 16)
Promotion of global partnership for SD	(SDG 17)

The survey has been sent to all the academics of the groups of contributors and participants analyzed with the bibliometric analysis using survey tool SoGoSurvey, and made available for a period of three months.

3. Results

3.1 Analysis of scientific production

Table 3 summarizes overall results of the bibliometric analysis of the two groups. It includes, from left to right, the number of people with or without Scopus ID, the number of papers (Np), the number of total contributions (Nt) and the percentages of them classified in Scopus Engineering subject; and in the second line, the total number of hits in different categories (Ncat), the ratio of Ncat over number of papers, the percentage of hits in Engineering, the number of hits of total contributions (Ntca), ratio of Ntca over total number of contributions, and ratio of them in Engineering subject.

It is interesting to highlight some differences between GDEE contributors and participants. First of all, contributors have a higher number of Scopus ID than participants. However, participants with Scopus ID are scientifically more productive, almost 21% more papers/person. Secondly, contributors' research publications (including both articles and total contributions), are more focused in the category of Engineering, than those of participants, more than 20% in both. Finally, contributor's articles are more interdisciplinary in nature, counting in average in 2,63 categories, versus 1,98 of participants and, equivalently, when considering total contributions.

Table 3. Summary of main characteristics of both groups analysed.

	Scopus ID	No Sc. ID	Num papers	Num total	Eng/Np	Eng/Nt
Contributors	31	12	220	352	60%	64%
Participants	22	25	362	536	36%	42%
Total	53	37	582	888	45%	51%
	Num categ.	Ncat/Np	Eng/Ncat	Num t. cat.	Ntca/Nt	Eng/Ntca
Contributors	578	2,63	23%	891	2,53	25%
Participants	715	1,98	18%	1003	1,87	22%
Total	1293	2,22	20%	1894	2,13	24%

Figure 1 presents the total number of scientific contributions of the two groups, respectively articles and all contributions, using Scopus classification (only categories with more than 10 contributions are displayed). Coherently with the target of the project, the average profile of GDEE academic has the most relevant activity in the field of engineering, followed by Environmental Science and Chemical Engineering.

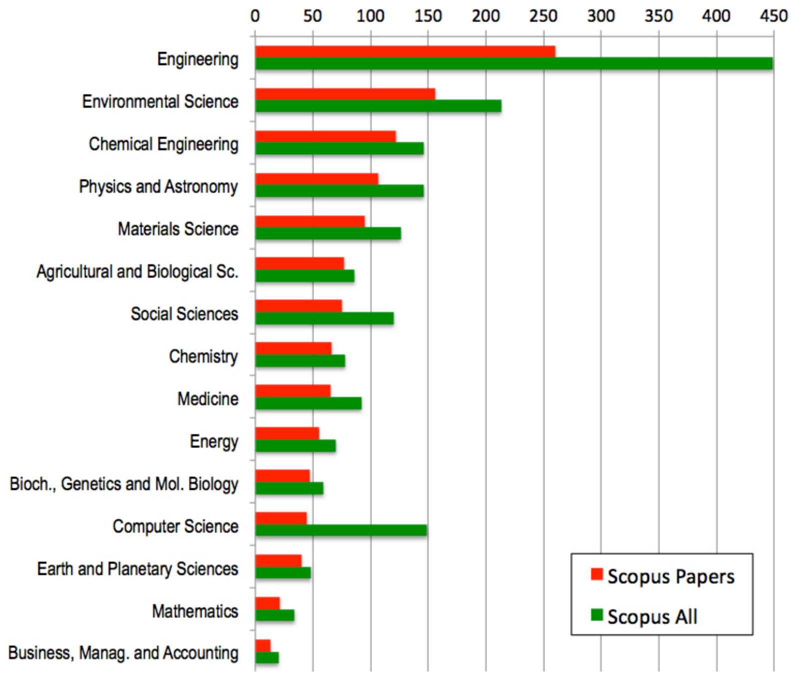

Figure 1. Number of papers and all contributions of GDEE community using Scopus classification.

Figure 2 presents the relative distribution of scientific publications using Scopus Subject Classification. Respectively, scientific articles and all contributions (comprising articles, book chapters, conference papers) of the two groups are displayed. Being engineering the predominant subject in both cases, it fixes the reference value for 100%. Then the order of subjects is fixed by decreasing the relative value of articles of contributors. It can be appreciated that the highest relevance of contributors is in Environmental Science and Social Sciences. Instead, the group of participants shows higher relevance in more categories (Physics and Astronomy, Materials Science, Agricultural and Biological Sciences, Medicine, etc.). Remarkably, the key areas that differentiate the two groups are Social Science and Medicine. In both categories, a particularly relevant research activity of one group is opposed to a significantly low activity of the other.

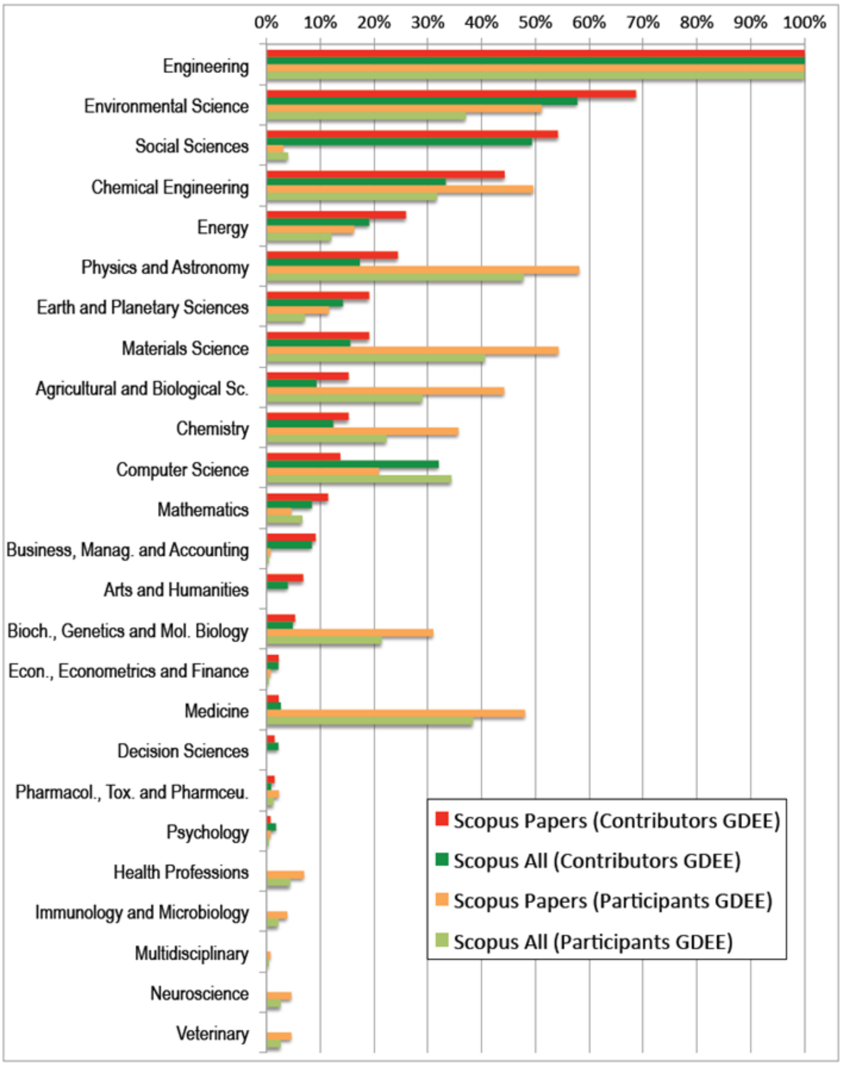

Figure 2. Relative distribution of articles and all contributions of GDEE community using Scopus classification.

These findings can be easily visualised in Figure 3 with the help of overlaid Science Maps. The figure shows the journals distribution of the scientific production of the two groups, highlighted onto a base map of global science (in light green), according to Scopus classification. At the top of the two maps are well visible the journals of Engineering fields (blue and yellow), predominant subject of research for both groups. Then, contributors and participants show journal distribution focused in opposed research areas, respectively left for journal categories related to social sciences journals and right for categories related to medicine, such as biotechnology, medical physics, radiology etc.

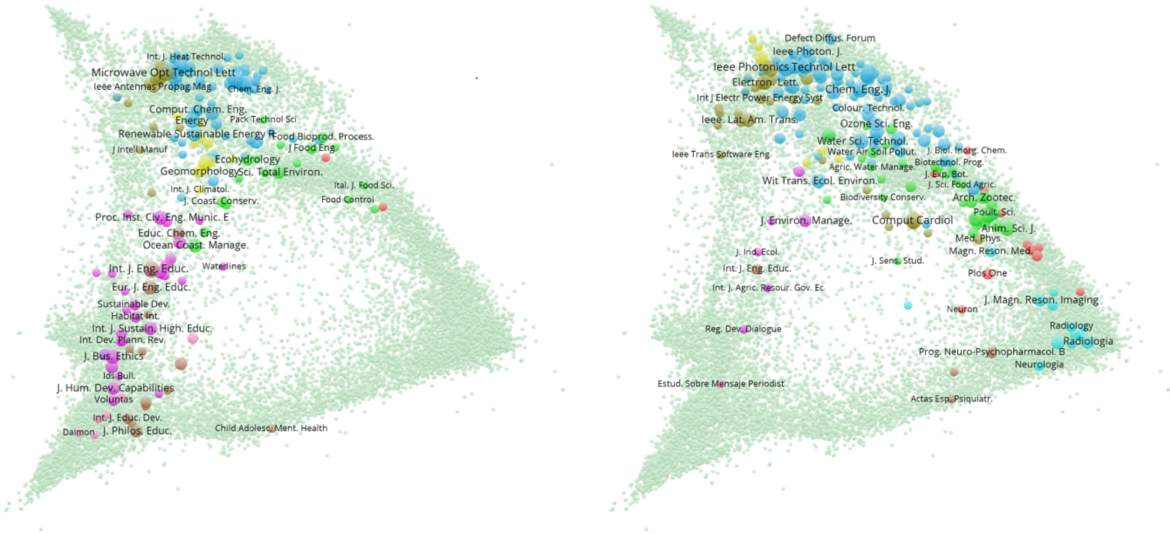

Figure 3. Journals distribution of the scientific output of 'contributors' (right) and 'participants' (left).

As outlined earlier, the information provided by science maps is particularly useful to assess interdisciplinarity of different portfolios of publications. Specifically, in the case of the two groups analysed, Rao-Sterling interdisciplinary index can be operationalized using the values of the distance among the respective subsets of journals provided by the map. The calculation of Rao-Sterling index shows that the degree of interdisciplinarity of the two groups is similar. In fact, the index is almost identical for the two groups, respectively 0,1848 for contributors and 0,1892 for participants. It can be visually appreciated that, although the spread across the map of the two groups is opposite, the relative distances between core engineering publications and other publications classified in different disciplines is similar.

3.2 Analysis of the survey

The survey was answered by 18 respondents from 7 HEI, representing the 33% response rate of all academics contacted. The responses were analyzed via statistical and descriptive analysis.

3.2.1 Profile of the survey respondents

Respondents' affiliation is mainly concentrated in Spanish polytechnic universities, respectively with 7 respondents from Polytechnic University of Catalunya, 4 from Technical University of Madrid and 3 from Technical University of Valencia. Other 3 respondents are from Engineering faculties of different Spanish universities: Castilla-La Mancha, Rovira i Virgili and Alcalà. Besides, an academic of the faculty of Architecture of the Universidade do Porto (Portugal), that completed GDEE courses through Spanish learning platform, has also answered the survey.

The majority of the respondents are doctors (83%), and females appear to be more motivated in answering the survey (56%). 56% of the respondents have age comprised between 40 and 49 years. The group of the respondents comprises juniors and senior researchers. Figure 4 shows the distribution of the years of professional teaching and research accredited by quality agencies.

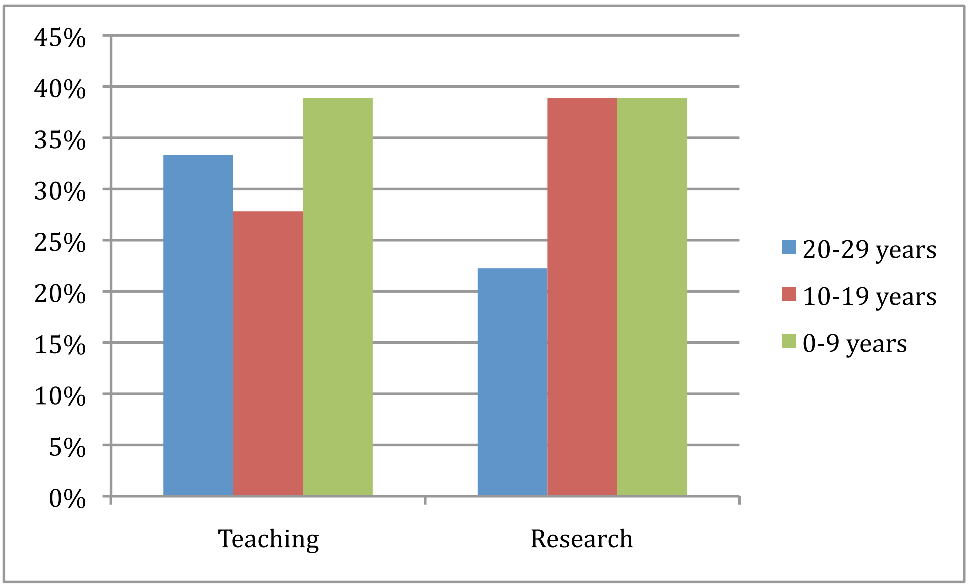

Figure 4. Distribution of accredited years of teaching and research

3.2.2 Teaching activities

The respondents were asked to indicate 1 to 3 subjects they imparted teaching, with reference to the last 5 years of their academic activity. Subsequently, they have been asked to deepen specific issues, specifically: i) the integration of mechanism of active participation of students; ii) the evaluation and grading criteria employed to evaluate students. In total 28 subjects were indicated by respondents, respectively 16 subjects of bachelor degree and 12 of master degree. Additionally, respondents were asked information on their engagement in activities of teaching innovation.

For the great majority (85%), the subjects indicated by respondents have mechanisms for the active participation of students. Among examples provided, shown in Figure 5, teamwork activities are, by far, the most important mechanism indicated, followed by online forum (offered via virtual platforms or social networks), then case study preparation and debates. It is worth mentioning a specific case highlighting teamwork activities in field work, in the framework of a subject partially developed on-field, in Morocco.

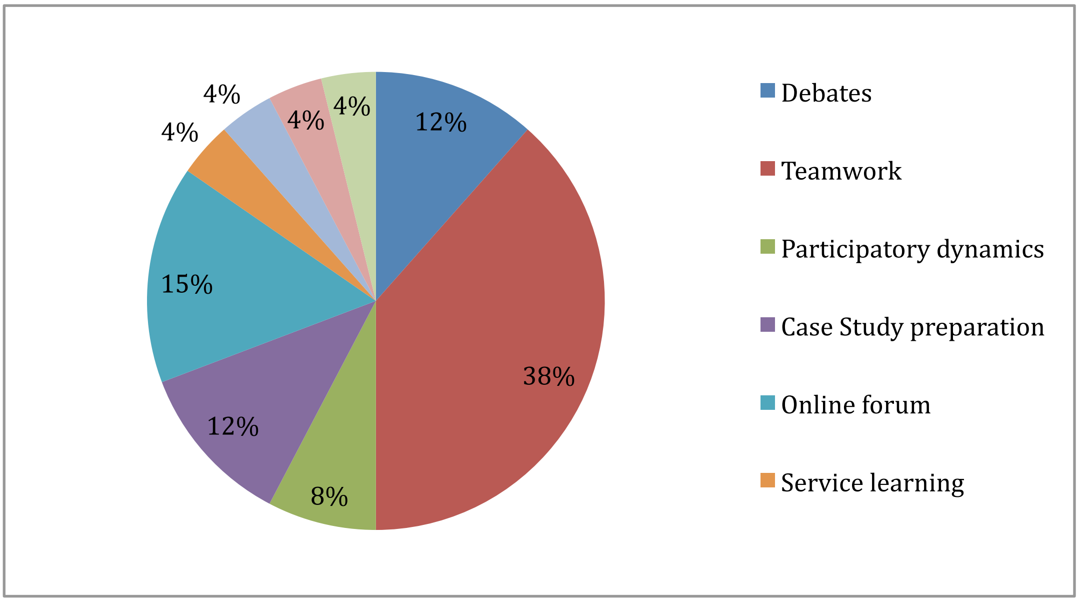

Figure 5. Active participation mechanisms

Figure 6 presents evaluation and grading mechanisms selected by respondents. It can be noted that, 'final exam' is the factor to which respondents give major importance, followed by 'teamwork' with a significant weight, and by 'independent work'. Peer evaluation is indicated as the less important factor considered in grading students.

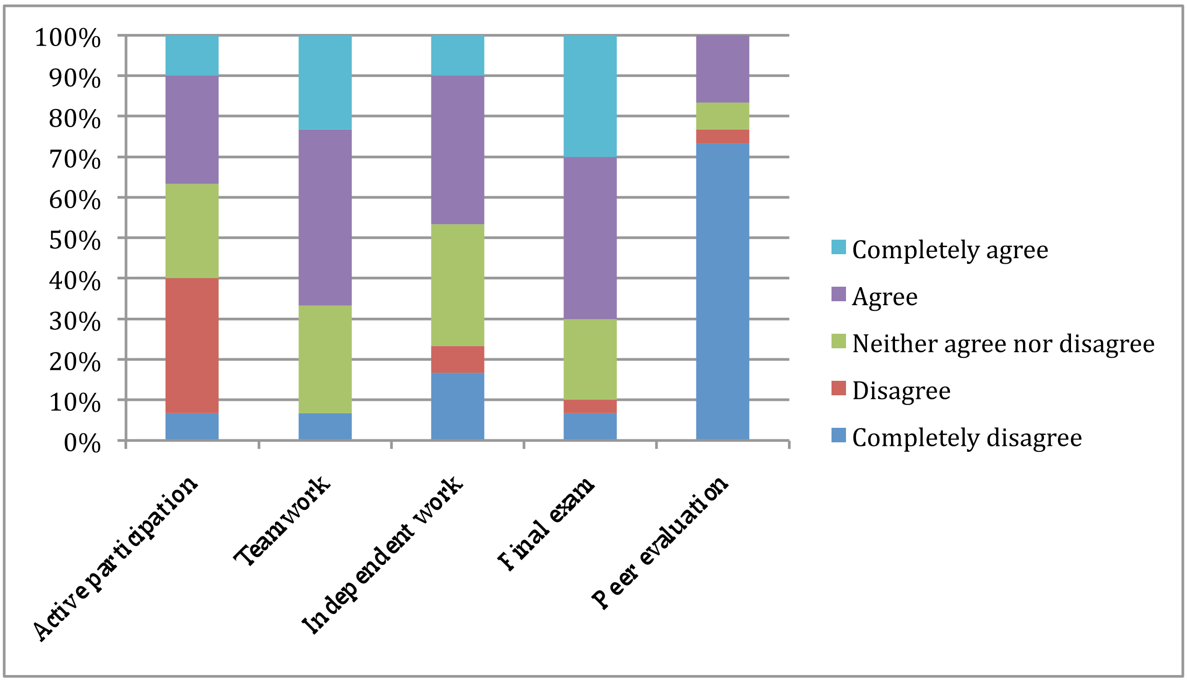

Figure 6. Evaluation and grading mechanisms

The great majority of the respondents (94%) indicates that respective universities have integrated transversals competences in their curricula. 83% of these academics considers that these competences are related to GD. 83% asserts that personally integrates GD in teaching activities through transversal competences and, respectively, the 67% and 61% considers that GD are also integrated in Bachelor/Master thesis and in other subjects of the courses of study.

Overall, the respondents are active in activities related to teaching innovation (Figure 7). It is noteworthy a significant activity as promoters of courses of teaching innovation (50%). 39% indicates that is author of publications or articles on this subject and only 22% participates in courses on teaching innovation. Among the most relevant issues specified as promoters, are noteworthy training activities relating SD (in its different variants as GD, SHD, Education for Development, Education for Sustainable Development) and engineering. Other issues indicated are: learning and service, urbanism, renewable energy and geographical information system (GIS).

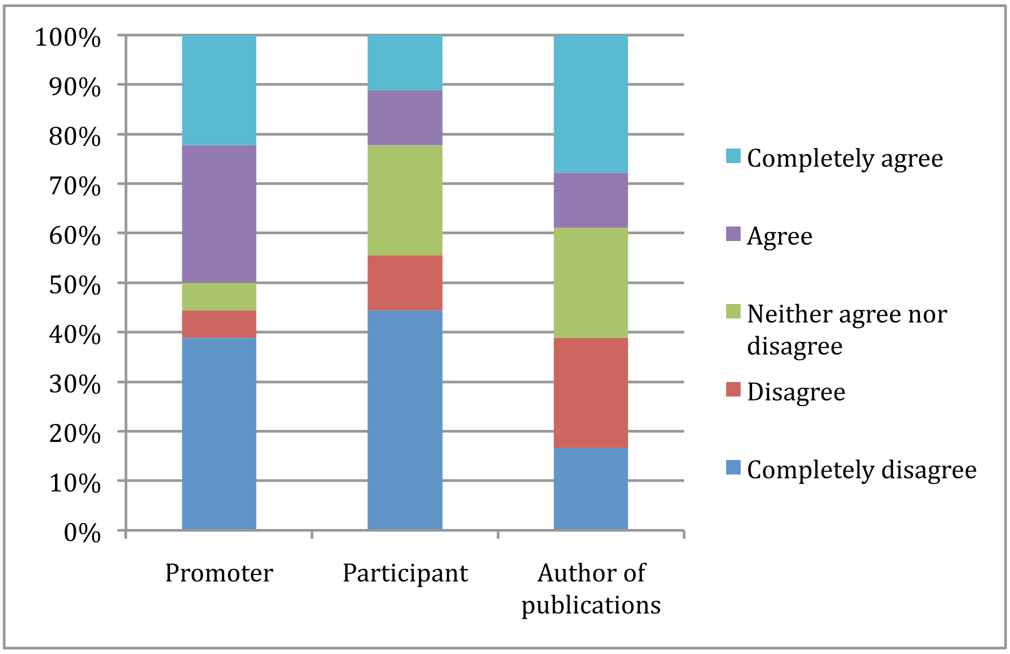

Figure 7. Engagement in teaching innovation activities

3.2.3 Research activities

The relation between teaching and research activities can be described, overall, as positive. Referring to the subjects indicated in the survey, 68% of the respondents points that the subject imparted are strongly correlated with their research activities. Besides, 94% considers that teaching and research activities reciprocally feed one another. This is confirmed in the related open-ended questions, where many academics describe that research driven in the area of SD provides the basis on which grounds most of their teaching activity. Specifically, case studies based on research outcomes are successfully used in class complementing theoretical issues. In fact, respondents highlighted that sharing with students the results of research initiatives brings credibility to the subjects imparted and is very well appreciated by students. It is also noted that teaching Master subjects adds personal flexibility of professors in prioritizing research topics that can easily be integrated into teaching practice.

3.2.4 Sustainable Development Goals

Figure 8 shows the degree of integration of SDGs in the teaching activities. The SDGs most integrated in teaching by the respondents were 'Climate change adaptation' (SDG 13), followed by 'Conservation and sustainable use of ecosystems' (SDGs 14, 15) and, in third place with the same value, 'Clean water and sanitation' (SDG 6) and 'Sustainable cities/communities and sustainable production and consumption patterns' (SDGs 11, 12). The SDGs with the lowest recognition were: 'Promotion of a decent work and sustainable industrialization' (SDGs 8 y 9), 'Promotion of peace, justice and strong institutions' (SDG 16) and, in the last position, 'Promotion of global partnership for SD' (SDG 17).

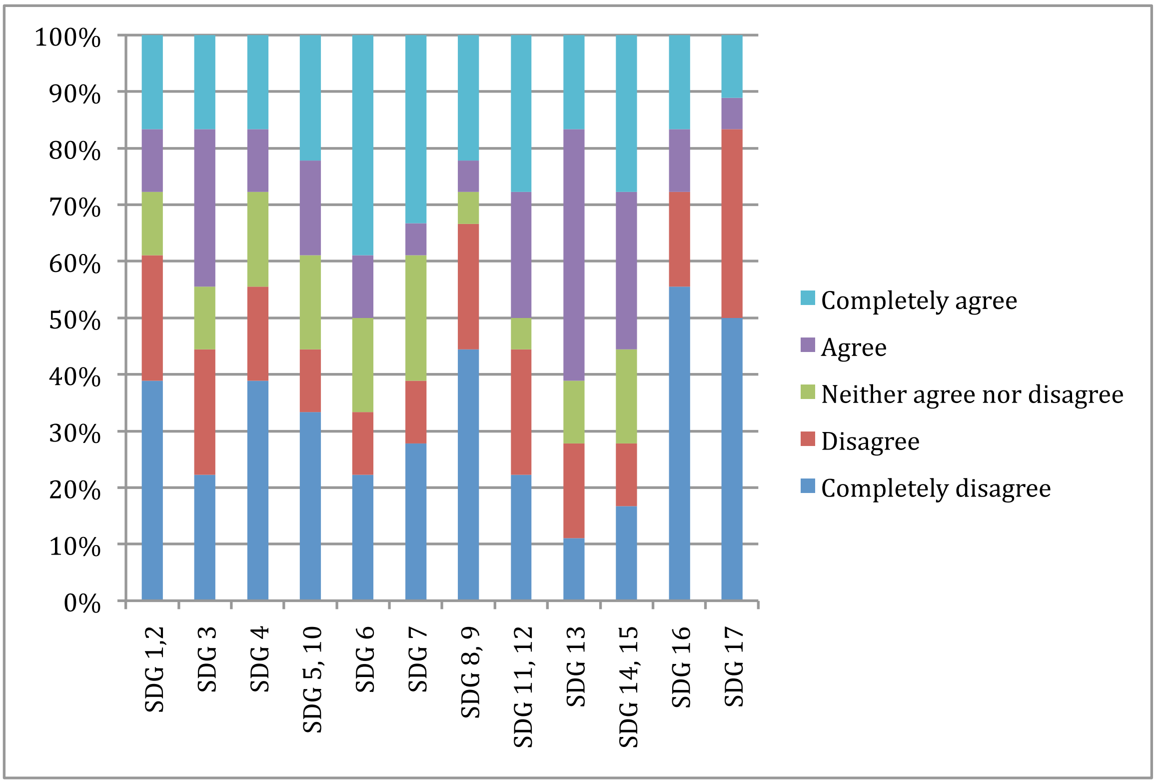

Figure 8. Integration of SDGs in teaching activities

Figure 9 shows the degree of integration of SDGs in the research activities. The SDGs most acknowledged were 'Conservation and sustainable use of ecosystems' (SDGs 14, 15), followed by 'Clean water and sanitation' (ODS 6) and 'Sustainable cities/communities and sustainable production and consumption patterns' (SDGs 11, 12). SDGs less integrated in research resulted: 'Promotion of global partnership for SD' (SDG 17), 'Affordable and clean energy' (SDG 7) and 'Promotion of peace, justice and strong institutions' (SDG 16), in the last position.

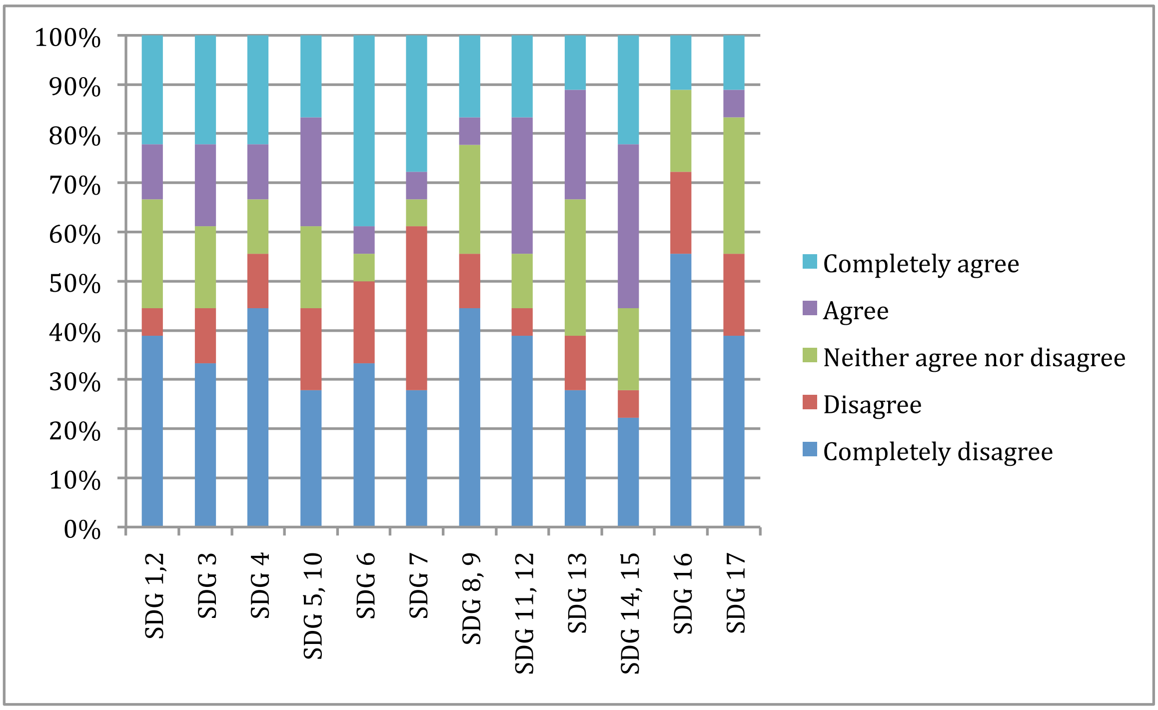

Figure 9. Integration of SDGs in research activities

A further question in this section was the perceived relation between SDGs and transversal competences implemented in respective universities. In this case, a percentage between 28 and 39% of the respondents opted to not answer to different items correspondent to SDGs. Supposedly, a lack of significant knowledge on the different transversal competences has conditioned the answers of this specific question. Those academic that chose to respond indicate 'Sustainable cities/communities and sustainable production and consumption patterns' (SDGS 11, 12) as the item that express the highest relation between transversal competences and SDGs, followed by 'Affordable and clean Energy' (SDG 7) and 'Conservation and sustainable use of ecosystems' (SGDs 14, 15). The lowest relation have been indicated respectively for 'Promotion of peace, justice and strong institutions' (SDG 16) and 'Promotion of global partnership for SD' (SDG 17).

3.2.5 Social Outreach

Respondents were asked to indicate with which type of entities they usually engage outside the university with the aim of disseminating their academic activities and the kind of relationship they have with such entities. Figure 10 presents respondents' engagement with different societal entities. Entities with the highest frequency are respectively: public entities, Civil society organisations (CSOs) and NGOs and International Development NGOs. Social and Environmental third sector are the entities with the lowest frequency. Figure 11 shows the specific relationship that participants have with each one of the entities specified. It is interesting noting that respondents engage with public entities because of the existence of project with financial allocation or due to institutional relationship. Instead, their engagement with CSOs/NGOs and International Development NGOs is mostly on own behalf. Student practice activities are mostly concentrated in domestic firms and SMEs.

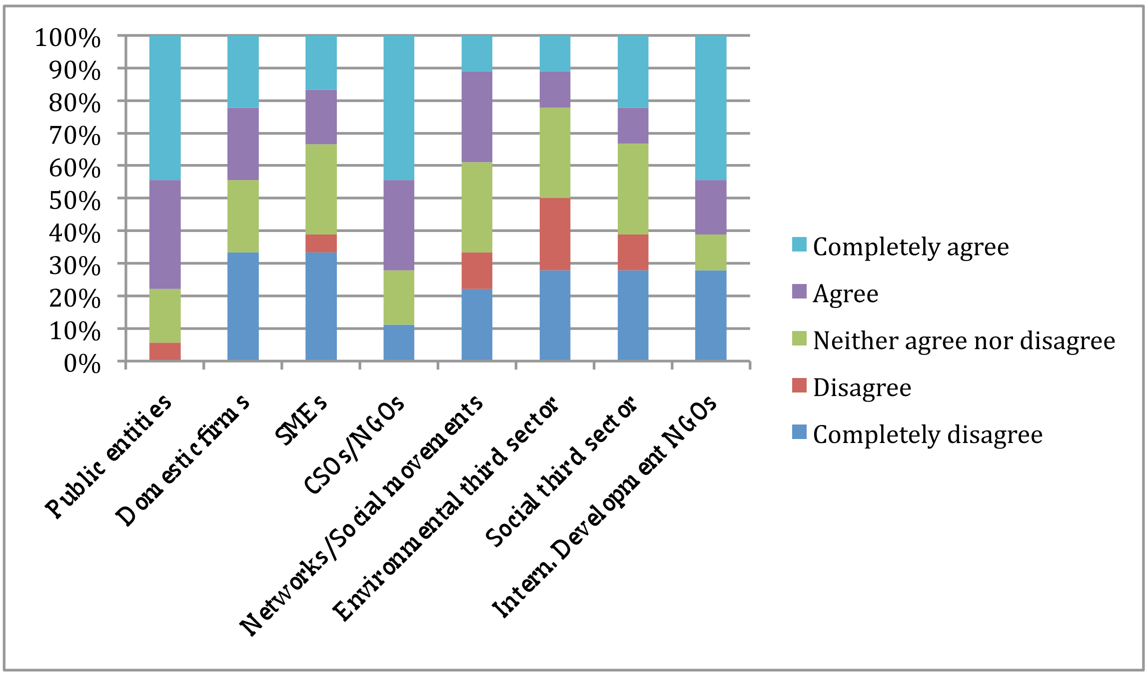

Figure 10. Respondents' engagement with societal entities.

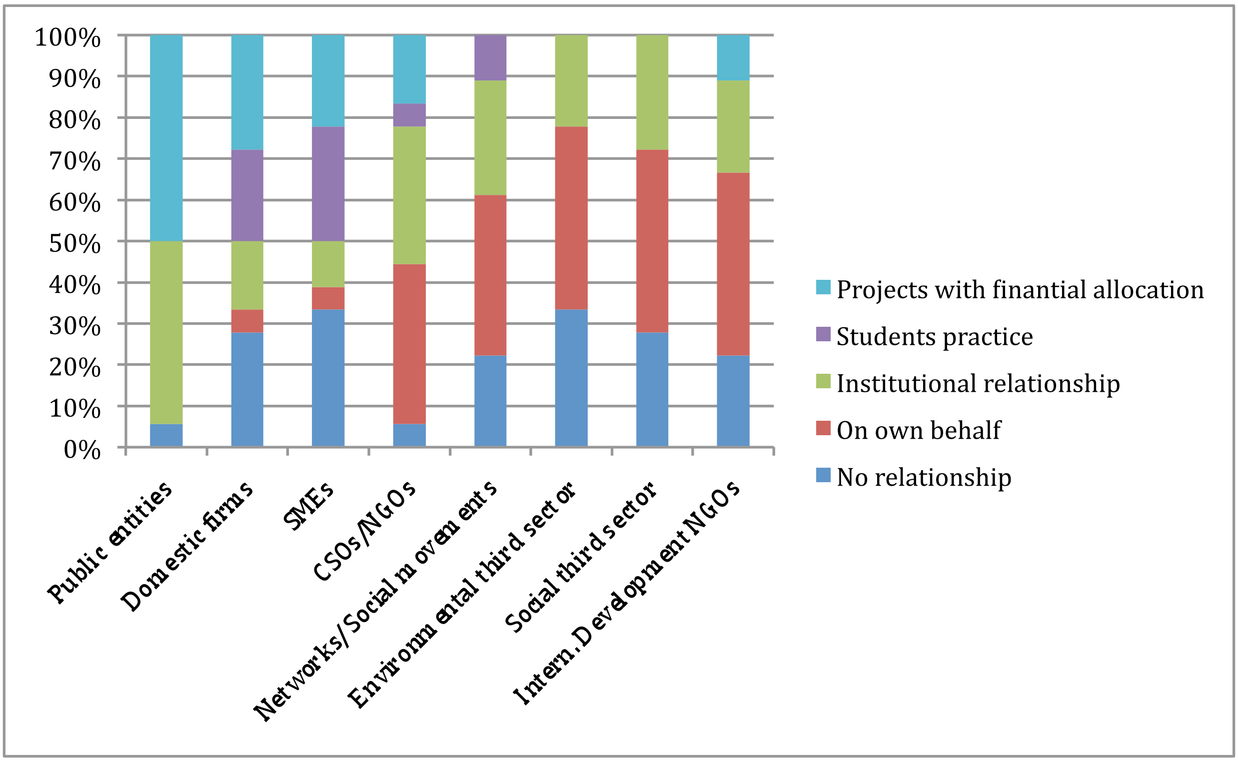

Figure 11. Respondents' relationship with social entities

Regarding the dissemination of research outcomes, respondents prioritize first quartile scientific journal, followed by international conferences and journals of all databases, as shown in figure 12. Dissemination addressed to a non-scientific audience, such as popular articles, blogs or press are the items with less relevance.

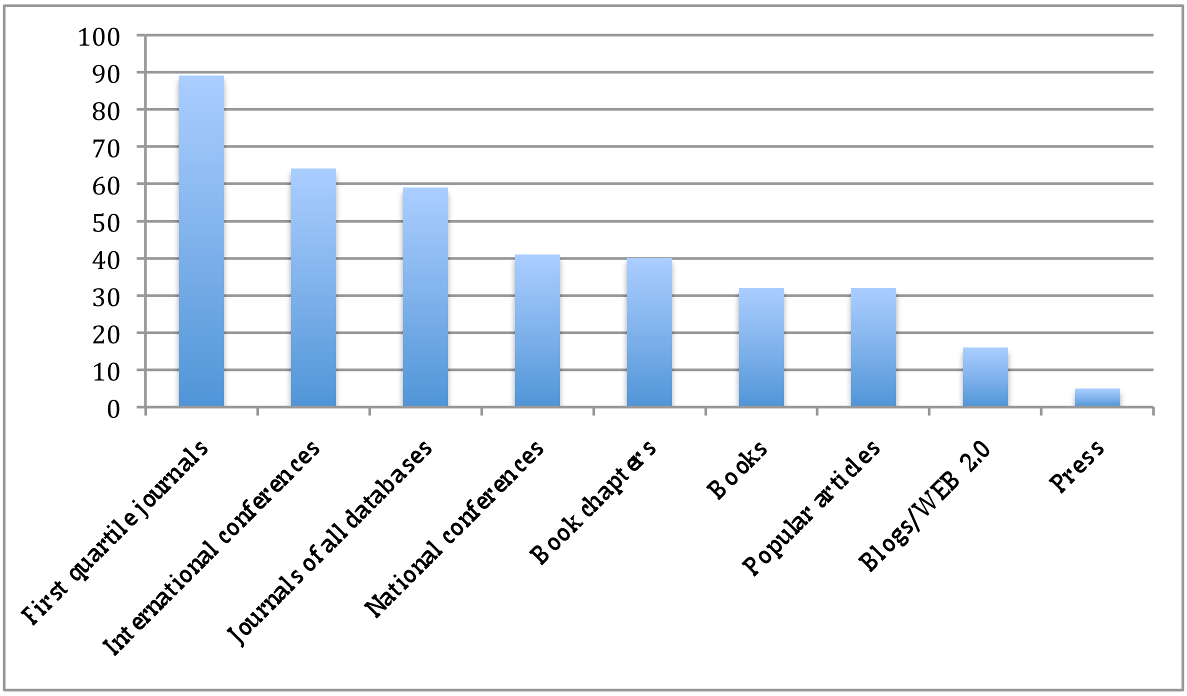

Figure 12. Dissemination of research outcomes prioritized by respondents.

3.2.6 Perception of the recognition/evaluation of academics merits

Respondents were asked to select, in a multiple-select question, all relevant items of the university monitoring of academic activity of professors. Research, with 90%, is the most relevant issue of the monitoring function that universities perform on academic activities, followed by teaching (83%) and knowledge transfer activities (78%). Social Outreach, unsurprisingly, has not been indicated as an aspect monitored by universities.

Universities evaluation mechanisms are not particularly well appraised by respondents. Despite the fact that the mode of Likert scale corresponds to the central value (neither agree nor disagree), a high percentage of the respondents (33%) of respondents emphasize a negative evaluation of the evaluation system.

Open-ended questions highlight both positive and negative factors related to the academic evaluation system. Among the formers, respondents pointed out resources allocation managed by universities, for example resources that the university dedicates to finance specific projects of research or doctoral scholarships. Another important issue highlighted is the reduction of the teaching load of faculty involved in successful research initiatives. The most critical views pointed out that the majority of activities carried out by faculty are not taken into account in the recognition of academic merits, and that research merits often are not considered for the reallocation of the teaching load among other colleagues.

According to the answers, almost 80% of the respondents has been evaluated by quality accreditation agencies. The majority values negatively the process of accreditation of academics pointing out different reasons. Firstly, they emphasize that the procedures for accreditation have burdensome bureaucratic requirements, often not entirely transparent. Secondly, some of them criticise the concept of academic quality accepted and applied in accreditation processes, especially stressing the ambiguity of criteria and scales that may lead to considerable disparities among colleagues. Finally, younger faculty stand out different accreditation requirements between seniors and younger academics. In the last decades, accreditation requirement have been tightened and more demanding requirements, such as leading a European project as Principal Investigator, now concern younger academics.

4. Discussion

The bibliometric analysis of the scientific publications of a reduced community of professors involved in GDEE training activities points out relevant issues. The two groups present interesting similarities. Both have their principal research production specifically focused in engineering-related disciplines and show a similar degree of interdisciplinarity research. The main difference between the two groups is that, whereas contributors have particularly relevant research activity in Social Science, participants are particularly actives in Medicine-related disciplines (biotechnology, medical physics, radiology etc.). It can be argued that faculty, including those with consolidated research trajectory and high degree of interdisciplinary research, are looking for a wider perspective and understanding of global challenges relevant to SHD, and their relations with the field of engineering.

This reflects wider societal debates that concern particularly higher education. Societal awareness on global challenges has tremendously increased in the last decade. A number of academics recognise critical challenges that need appropriate engineering solutions that current engineering formal training could hardly provide. On the other side, student themselves are demanding a re-thinking of the content and the form of engineering curricula.

The survey, even with the limitations related to the reduced number of respondents, highlights important issues related to academic activity that complements the information provided by the bibliometric analysis. Focusing on teaching activity it is worth emphasising that results indicates that transversal competences adopted by universities are, for the great majority, related to the GD. Besides, respondents state that global dimensions are integrated, through transversal competences, in different subjects of the courses of study, as well as through Bachelor/Master thesis. From one side, this shows that there has been considerable integration of SD issues throughout Spanish university system, specifically regarding engineering faculties. From the other side, this contrasts with scientific literature (Davidson et al., 2010; Lozano and Lozano, 2014) that substantially indicates that incremental improvements, basically focused on individual courses on SD, are more commons in engineering faculties (von Blottnitz et al., 2015). For this reason, it is important further exploring the effective integration of SD in engineering courses.

Also research activity is indicated, by the large majority of the respondents, as strongly integrated with teaching and with positive mutual feedback. Again, this favourable condition is not consistent with the literature that highlights, conversely, the lack of integration of these university functions as a barrier to further engage in efforts towards SD (Verhulst and Lambrechts, 2014).

The degree of integration of SDGs in teaching and research endeavours is mostly related to topics traditionally closer to scientific and engineering competences while, unsurprisingly, other relevant topics more related to Social Science and Humanities such as gender equality, poverty reduction and inclusive/equitable education show lower levels of integration. The mechanistic separation of disciplines and the lack of the ability to work across different fields is recognised as one of the major challenges of engineering curricula reform.

The analysis of social outreach describes academics engaged primarily with public entities due to funded projects and institutional relationship. Conversely, their engagement with social entities such as CSOs/NGOs is mostly at a personal level. Furthermore, the efforts aimed at disseminating scientific outcomes are mostly concentrated to scientific contexts while popular dissemination is quite insignificant. This description is consistent with other analysis on the role of academics in the contemporary university that describe an increasing “corporate approach” of HEI where managing is emphasised over thinking and academics spend an increasing amount of time on managing activities and administrative requirements and less time is dedicated to public service (White, 2015). Furthermore, these results underpin the critics of different agents of the social sector, such as CSOs/NGOs, stating that university has been unable to enhance collaboration channels with social entities.

Finally, it is worth emphasizing the critical view that most of the academics expressed on the evaluation system, at both levels of universities and accreditation agencies.

5. Conclusions

During the last decades, a growing numbers of HEI have been engaged in refocusing their educational and research functions towards SHD principles. Engineering covers all aspects related to human development and it is essential that professional engineers be able to respond adequately and urgently to global challenges. Polytechnic universities and engineering faculties have made major progresses in this direction. Nevertheless, more efforts are needed in order to advance to in-deep curricula reforms. The practical and structured orientation of engineering education and methods, make particularly challenging the promotion of a cultural shift towards frameworks of knowledge defined by uncertainty, complexity and cultural sensitivity.

This work was specifically addressed at enhancing the understanding of the academic profile of faculty engaged in training activities related to SHD, with the aim of improving and fostering the replicability of similar initiative in different contexts. The results indicate that SHD experts involved in GDEE activities are academics whose research range from engineering to social science and are involved, for the great majority, in activities with social entities and movements. In other word, they may be described as promoters of those educational principles and values that can facilitate a cultural change in engineering education. To successfully promote initiatives similar to GDEE, trainers with academic profiles that conjugate expertise in engineering and social science can be beneficial not only for training participants but can also indirectly contribute to stimulate processes of cultural change in HEI.

A critical aspect emphasized by results is related to the role of academics as potential change agents for the society. This research confirms that academics are not sufficiently engaged, through their activities, at facilitating a transition of societal setting toward SD. Even if the research pointed out the linkages of academics with different social organisations and movements, it is worth noting, reversely, that the dissemination of their scientific activities is addressed almost exclusively to academic audiences. This is consistent with the fact that social outreach has been indicated as an aspect not monitored by universities. Consequently, a challenge that remains is how to foster a more fruitful and intense collaboration between researchers and social entities, starting from a proper outreach.

Universities are expected to function as leaders of societal change towards sustainability. For this reason, they should support and recognise in their policies all those activities and initiatives aimed at promoting, in non-academic contexts, a deeper understanding of global challenges and social debates on possible policy solutions. Initiatives such the GDEE can contribute at enhancing liaisons outside academia through specifically skilled trainers and activities designed jointly by faculty and CSO/NGOs.

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Comparative study on the program design of three sustainability science programs based on the CIPP framework

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Abstract

In response to emerging "wicked" sustainability challenges, educational programs in universities are urged to train individuals with high level of awareness to sustainability issues, key competencies for case analysis, and leadership to guide social changes for sustainable society. Today, over 200 sustainability-related degree programs are offered worldwide, however most of the programs are embedded in existing disciplines (i.e. mostly in Environmental Studies). The debate of structuring sustainability science as its "own discipline" is emerging, which emphasizes the discipline's key features of problem-based approach, transdisciplinary perspective, and normative dimension of sustainability discourse. While earlier literature addressed the disciplinary establishment, empirical understanding on the educational implementation of sustainability science is lacking. To address this point, this study examines the program design of sustainability science programs through the pilot case study of three graduate programs: Graduate Program in Sustainability Science (GPSS, The University of Tokyo), School of Sustainability Science (SOS, Arizona State University), and Lund University Centre for Sustainability Studies (LUMES/LUCSUS, Lund University). We apply Stufflebeam's CIPP framework as a guiding principle—Context covers the program philosophy that reflected in missions and visions statement; Input analyses program curricula, faculty members, and facility of the program; Process examines the implementation of curriculum, and Product looks into the outcome of program. The finding shows that sustainability science programs generally agree on the missions and visions of producing human resources that contribute to sustainable society, providing inter- and/or transdisciplinary research platform, and delivering students with sets of competencies and skills for sustainability. However, their approaches are different greatly with its focus on education, research, and social implementations. Based on the findings, this study argues that the linkages among offered courses and divergence between education and research in sustainability science are two main discussion points for further development of sustainability science programs in higher education.

Keywords: sustainability science, program evaluation, CIPP, higher education

1. Introduction

Today, we live in the era in which the environmental pressures caused by human activities are reaching the limit of ecosystem capacity and the persistent development challenges are continuously emerging (Griggs et al., 2013; Rockström et al., 2009; Steffen, Crutzen, & McNeill, 2007). These challenges related to sustainability are also known as wicked problems; these problems have complex structures and single solutions cannot solve the status quo (Lazarus, 2009; Levin, Cashore, Bernstein, & Auld, 2012; Rittel & Webber, 1973). In response to such complex challenges, sustainability science has launched and promoted vibrantly in research and education.

Seminal works of sustainability science literature describe that the central focus of the discipline is to elucidate the complex and dynamic interactions between nature and society (Clark &

Dickson, 2003; R. W. Kates, 2011; Robert W Kates et al., 2001; Ostrom, Janssen, & Anderies, 2007). The discipline also places its emphasis on analyzing the inter-scale linkages among global, national, and social systems (Komiyama & Takeuchi, 2006). Such perspective perpetuating across different scales is also explained as holistic and transboundary approach (Mino et al., 2016).

In reflection of the global sustainable development advocacy emerged from the historical launch of the concept by the Brundtland Report (WCED, 1987), knowledge contribution of sustainability science for achieving sustainable development is also articulated (Martens, 2006; Parris & Kates, 2003). In order to actualize such stand to sustainable development challenges, sustainability science needs to be “defined more by the problems it addresses rather than the disciplines it employs” (Clark, 2007; Spangenberg, 2011). Employing problem-based approach, sustainability science has the feature of interdisciplinarity which cuts across natural science, social science, and humanities, and also the feature of transdisciplinarity that integrates academia and society by active engagement with social stakeholders (Clark & Dickson, 2003; Kajikawa, 2008; R. W. Kates, 2011; Lang et al., 2012; Martens, 2006; Parris & Kates, 2003; Wiek, Farioli, Fukushi, & Yarime, 2012). For such collaboration with stakeholders, researchers are required to have skills to provide multiple-levels understandings on the structure and dynamics of sustainability challenges (Jerneck et al., 2011; Ness, Anderberg, & Olsson, 2010; Olsson, Jerneck, Thoren, Persson, & O’Byrne, 2015).

Despite its relatively young history, sustainability science has been creating its own space in academia (R. W. Kates, 2011). Earlier literature analyzed research topics, research-related collaborations, and cross-citations in publications in sustainability science and they found well-established academic landscape of sustainability research across regions (Bettencourt & Kaur, 2011; Brandt et al., 2013; Kajikawa, Ohno, Takeda, Matsushima, & Komiyama, 2007; Kajikawa, 2008; Yarime, Takeda, & Kajikawa, 2009). Especially the recent work of Kajiawa and his colleagues highlights that the disciplinary focus of sustainability science has been shifting to the integration of research clusters both in between scholarship and practice, and in across global to local perspectives (Kajikawa, Tacoa, & Yamaguchi, 2014). Supported by these early contributions, to date, it can be said that the core structure of sustainability science as an academic field has been formed and its key features such as problem-based and solution-oriented approaches, interdisciplinary and transdisciplinary stands, and normative discourses on sustainability are identified (Brandt et al., 2013; Clark, 2007; Jerneck et al., 2011; Kajikawa, 2008; Lang et al., 2012; Spangenberg, 2011; Tainter, 2010; Wiek, Withycombe, & Redman, 2011).

Sustainability science education program at higher education

While such progressive development of sustainability science research has been accomplished, another key component of the discipline is its educational development. Higher education, in particular, is urged to integrate the sustainable development concept (Calder & Clugston, 2003; Cortese, 2003) and train individuals with high level of awareness on sustainability concept, key competencies for problem analysis, and leadership to guide social transformations for future sustainable society (Brundiers & Wiek, 2011; Wiek et al., 2011). Since the Stockholm Decralation in 1972, the integration of environmental sustainability into higher education curricula has been emphaseized through several national and international declarations (Wright, 2002). However, actual implementation has remained as a challenge for universities as their compartmentalization, over-specification, and reductionistic orientations tend to be the barriers and each department only adopts the SD concept partially in a specific dimension (Lozano, 2010).

As of 2016, there are 232 sustainability-related degree programs offered at university level across the United States, Canada, Australia, United Kingdom, Japan and few other countries (SSPP, 2016). Expansion of sustainability-related programs is particularly evident in the United States as there are 151 programs that compose more than 65 percent of all the programs. Among other countries, Australia, Canada and United Kingdom have relatively larger number of programs, yet they are all less than 10 programs in each country. The majority of these programs is at the Master’s degree level; there are 125 programs (53.9 percent of the total) in 16 countries and 1 online program. There are 26 doctoral programs in 10 countries, which consists only 11.2 percent of the total.

Currently, majority of the sustainability programs in higher education is offered as one of the components of larger educational program such as Environmental Studies, Engineering, and Development Studies. O'Byrne and his colleagues conducted a comprehensive evaluation of existing sustainability programs and they found that the number of natural science courses in existing sustainability programs is generally limited. Although the integration of natural and social sciences is proposed in the earlier literature, such integration has yet to be actualized (O'Byrne, Dripps, & Nicholas, 2015). Co-design and co-creation with stakeholders is also recognized as an essential component of sustainability science (Trencher, Yarime, McCormick, Doll, & Kraines, 2013; Yarime & Trencher, 2012), however the integration of such feature into educational programs require specific design of curriculum while it is argued that the best individual researchers can do is, perhaps, to hold their mindset for "transdisciplinary-ready" (or even interdisciplinary-ready at the best) in actual research projects (Spangenberg, 2011). Given the current situation of sustainability science education, how much an educational program can improve its design and contexts to deliver such individuals with balanced knowledge across different academic knowledge and transdisciplinary mindset is the subject of further discussion.

Purpose of the study

For the further development on the design of sustainability science education programs, evaluation of existing sustainability science programs is urged. Besides few contributions in early literature, currently research on existing sustainability science programs is scarce. In response to such research gap, this study aims to examine the design of sustainability science education empirically with the application of the CIPP (Context, Inputs, Process, and Product) framework developed by Stufflebeam (Stugglebeam, 1983). Through this contribution, this study aims to advance the current program design of sustainability education programs at postgraduate education level.

The scope of this study is on the design of sustainability science education programs, therefore the analysis of this study is concentrated on the context and the input components of target sustainability science programs based on the CIPSS framework. More specifically, this study comparatively investigates program philosophy (mission and visions), curriculum, and course contents. Authors are aware that additional examinations of the process and the product components such as the quality of each course offered or performance of graduates are required to complete an evaluation based on the CIPP framework. However, program assessment needs to be conducted while programs are under the development. As the first step of such evaluation, this study focuses on the program designs.

2. Methods

CIPP framework to examine sustainability science programs

As the overall framework for analysing the design of sustainability science programs, this study applies the CIPP framework (Figure 1; Stufflebeam, 1983). This framework allows a systematic examination on different components of a subject. The CIPP framework has also been widely applied in evaluation of educational programs (e.g. Daniels & Khanyile, 2013; Mohebbi, Akhlaghi, Yarmohammadian, & Khoshgam, 2011; Zhang et al., 2011).

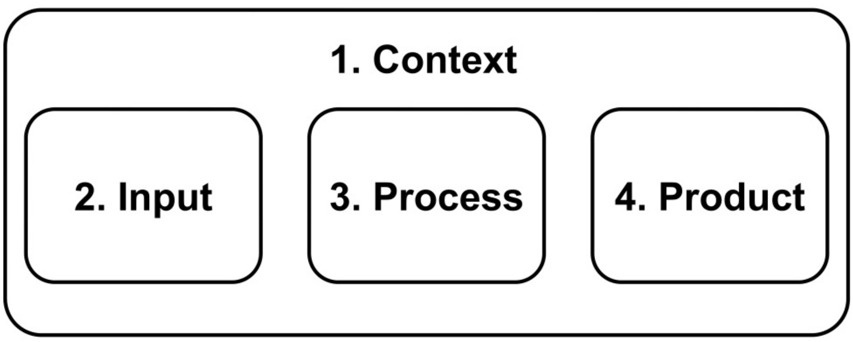

Figure 16. CIPP Framework (Based on Stufflebeam, 1987)

The CIPP framework consists of four components (Figure 4). The first component is the context, which examines those aspects related to the foundation of each sustainability science program. Basically, the context asks "what should we do?" as a sustainability science program. Based on this idea, missions and visions of program should convey key elements for answering to this central question of the context. In this study, mission is interpreted as the way the program aims to interact with the society, and its methods. Vision in this study implies the image of the state to which the pursuit of the mission should lead to as its outcome. The context also includes the institutional background as well as the addressed issues; it therefore defines the educational goals and scopes. In sustainability science, the research scope is inherently diverse where the development and outcomes of a program is shaped by its context based on its problem-based and solution-oriented stand. This study examines indicators that include program philosophy, mission and vision.

The second component of the CIPSS framework is the inputs. This component addresses the question of "how we do it?" through examining the program curriculums, faculty and facility. Among these components of the input, program curriculum is considered as the core component of a program as it allows the program coordinators to reflect their own interpretation of sustainability and design program contents accordingly. The existing knowledge of students, their research interests, and cultural backgrounds are among the factors that contribute to the program, especially in terms of diversity.

The third component is the process, which looks into the implementation of the designed program. This component examines the performance of program conductors in terms of the quality of program implementation. For instance, the quality of lecture-based courses should be evaluated based on the knowledge, practical methods, and discussions offered. The process should also examine the quality of advisorship for Master's and Doctoral thesis. Many of these aspects that belong to the process can only be evaluated qualitatively, and such evaluation needs to be done as a simultaneous evaluation.

Lastly, the fourth component, the product, implies the result of educational program. The product includes tangible and intangible outcomes, where tangible outcomes are represented by paper publication, projects awarded, enterprise partnership, policy formulation, and the intangible outcomes include the competencies of graduated students, new view in sustainability issue. As it was explained earlier, these two components, the process and the product, are not analysed in this study. This second phase of evaluation will be done in the authors' future contribution.

Comparative analysis of three sustainability science programs

The CIPP based assessment is the key for reflexively improving the program. However, without applicable criteria in sustainability science programs, the assessment lacks reliability and validity. To avoid subjective bias such as selection of indicators which are in favour of our own program, the criteria should be set based on the review of similar programs. In that respect, we have decided to set our main target of examination to three graduate level programs in sustainability science in this study: School of Sustainability Science in Arizona State University (ASU), two programs in sustainability studies in Lund University (Lund)22, and Graduate Program in Sustainability Science in The University of Tokyo (GPSS). These three programs were established at early time in the close time period, and they all provide both Master's and Doctoral degrees in sustainability science. Details of each program are provided below.

School of Sustainability, Arizona State University (ASU)

ASU is a pioneer in establishing degree programs in sustainability science in the United State. It offers Bachelor of Arts and Sciences, Master of Arts and Sciences, and Doctor of Philosophy that

[22] These two programs are Lund University International Master's Program on Sustainability Studies (LUMES) and Lund University Centre for Sustainability Studies (LUCSUS).

focus on finding real-world solutions to environmental, economic and social challenges. ASU actively employs transdisciplinary approach by integrating co-design and co-implementation of projects with local stakeholders around the local community. School of Sustainability in ASU has more than 97 faculties (which include graduate faculty and adjunct faculty) and 70 graduate students. They cover research area of business practices and economics, climate change and adaptation, policy and governance, and other sustainable development challenges. The history of establishment dates back to 2002 when Michael M. Crow, the 16th president of the university, declared sustainability as the university-wide defining principle. He convened global sustainability leaders in Temozon, Mexico for designing the sustainability initiatives. Julie Ann Wrigley, a businesswoman, joined and sponsored 15 million US dollars to kick-start the Global Institute of Sustainability, which has become the hub of sustainability of ASU. School of Sustainability is later established in 2006 as a part of their sustainability initiative. In recent years, School of Sustainability has expanded to offer more sustainability certificate programs, minors, professional leadership and other application-oriented programs, which are tailored for different professional advancement, e.g. retraining of corporate staffs. ASU envisions its graduates to become equipped with sustainability competencies, i.e. system thinking, normative, anticipatory, strategic, and interpersonal competencies.

Lund University Master Program in Environmental Studies and Sustainability Science (LUMES), and Centre for Sustainability Studies (LUCSUS)

LUCSUS is the platform for education, research and cooperation that relate to sustainable development issues in Lund University, Sweden. It has been offering International Master's Programme in Environmental Studies and Sustainability Science (LUMES) since 1997. Their programs uniquely emphasize on diverse background of students. The 40 students that enrolled in the last admission come from 28 different countries and represent training in eight different academic disciplines (as of December 2015). LUMES was previously rooted in environmental system analysis and government studies, but later transformed into comprehensive study in sustainability science. Nowadays, LUMES takes critical and system thinking approach for education instead of focusing on particular methods or tools. In addition, LUCSUS established a doctoral degree program in sustainability science, Lund University Centre of Excellence for Integration of Social and Natural Dimensions of Sustainability (LUCID) in 2008. It is funded by Linnaeus Grants, which is sponsored by the Swedish Research Council for the period of 2008 to 2018. LUCID aims at synergizing natural and social sciences to address complex sustainability challenges. The steering committee constitutes representatives from the six collaborating disciplines, i.e. LUCSUS, Human Ecology Division, Department of Political Science, Department of Social and Economic Geography, Department of Philosophy, and Department of Physical Geography and Ecosystems Science. LUCID envisions a three-phase integration of knowledge over ten years, i.e. advances from multidisciplinary towards interdisciplinary and transdisciplinary in solving sustainability problems.

Graduate Program in Sustainability Science (GPSS), Graduate School of Frontier Sciences, The University of Tokyo

GPSS is an interdepartmental program for sustainability science located in The University of Tokyo, Japan. It is jointly operated by six departments in the Division of Environmental Studies, which are Environment Systems, Human and Engineered Environmental Studies, International Studies, Natural Environmental Studies, Socio-Cultural Environmental Studies, and Ocean Technology, Policy and Environment. It has been offering two-year master program since 2007; and followed by the three-year doctoral program since 2009. Today, GPSS has more than 50 affiliated faculties and 60 graduate students from 20 different countries (as of March 2016). GPSS situates three key concepts for its program design: holistic, resilient, and transboundary. Having resilience concept is unique in the Japanese context, especially the resilience against natural disaster after the Great Eastern Japan Earthquake and the resilience against social change such as aging society. GPSS was initially founded as an educational program of Integrated Research System for Sustainability Science (IR3S), a leading network in developing sustainability science in Japan. In 2012, the Ministry of Education Culture Sports and Technology (MEXT), Japan selected

GPSS as a “Leading Program in Doctoral Education”. Through this initiative, GPSS envisions to advance research, link societies, develop an international meta-network, and train the next generation of leaders responsible for global sustainability.

Data collection

Data collection for the context and the inputs based on the CIPP framework for three programs were primarily done through the official program websites, journal papers, and other reference documents[23]. Based on the information, a base matrix was created (Table 1). This base matrix was distributed as inquiries to each program coordinators for institutional confirmations through our network of sustainability science programs. This process provided an authorisation on all the information on the created matrix through this study (Table 1).

Along with this communication, we also asked for the detailed information about program syllabus, course syllabus, and compulsory (or core) and elective courses. Particularly we assume that those topics covered in core courses reflect the program’s emphasis in sustainability science, as it is a common discussion what disciplinary subjects should be included as the core courses and other subjects as elective.

3. Results

Context of three programs

To identify the context of three sustainability science programs, program philosophy, additional keywords, mission, and vision were examined. The matrix provided as Table 1 shows the context overview of three target programs.

Firstly, in the program philosophy, “transdisciplinary” appeared as one of the key components. However, the meaning it employs appeared slightly different among the programs. The integration of knowledge from multiple disciplines is stressed in Lund while the provision of adaptive solutions for dynamic of coupled socio-ecological systems is emphasized in ASU. GPSS applies “transboundary” as a similar concept to transdisciplinary, which stresses the interactions across different scales from local to global when addressing sustainability challenges. One major difference is found in GPSS, where additional three key concepts in its program philosophy, “resilience”, “holistic”, and “leadership” were found. These concepts were not found in both mission and vision of Lund and ASU.

Secondly, although all three sustainability science programs envision nurturing human resources that can contribute to creating future sustainable world, their approaches appeared differently in their mission. GPSS emphasizes its educational component more than other two programs by stating one of the program’s main missions as to develop international education network for sustainability. Experiential education through fieldworks and internships is embedded as its key program design in GPSS such as its Global Field Exercise and Resilience Exercise courses. The mission of GPSS also includes the problem solving component through collaboration with private sector and interdisciplinary orientation within the university. In contrast, sustainability programs at Lund state their main missions as the development of strong transdisciplinary research in sustainability. LUCSUS particularly aims to be the hub of sustainability research both nationally and internationally. The program aims for the integration of human, social and natural dimensions of sustainability through problem solving and critical research strategies. The development of new theories and methodologies in sustainability research is an important component of their programs. For that purpose, their mission also emphasizes the global network of outstanding partners on sustainability research. In the case of the School of Sustainability, ASU, their program mission is more oriented toward the linkage between academics and practitioners for implementation of sustainability solutions. In other words, ASU stresses knowledge contribution to sustainability in action in its mission. ASU places an importance on partnership with cities, non-profit organizations,

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[23] Data of ASU were obtained from the Gradaute Handbook 2015-2016, Master of Arts (MA)Master of Science (MS). Available at https://schoolofsustainability.asu.edu/docs/sos/SOS-GraduateHandbook2015-2016-MA-MS.pdf

and local businesses. Through such partnership, ASU provides educational opportunities for students to provide sustainability thinking to those partner organizations.

Thirdly, additional keywords appearing in the program outline are analyzed. Across all three programs, problem solving (or solution-orientation) is commonly found as their core interest. This point is also well reflected in the existing sustainability science literature (Clark, 2007; Miller et al., 2014; Spangenberg, 2011). Another common keyword was leadership in GPSS and ASU. Leadership implies the ability to design and apply sustainability solutions in society for ASU while its definition is not clearly provided by GPSS. Lund, on the other hand, does not include "leadership" in their context components, yet "action-oriented outreach focus" is there as their additional keyword to describe their programs.

Following the clear differences in their missions, program visions of three programs also present number of major differences. Visons of Lund program shows strong linkages from their missions as they envision creating a research platform that "advances and problematizes the role of science in the transition towards sustainability" (Table 1). Their future vision is linked to become a major player of integrated knowledge in sustainability research. ASU's vision also keeps its linkages to its mission, which emphasized leadership component. Their vision also includes the word "lead" and shows their interests in designing and leading social and environmental changes towards future sustainable society. GPSS, in contrast, elaborates new perspectives in its vision. The program values global leadership, problem solving capabilities and the ability to apply the concept of resilience both theoretically and practically. Although its appearance in vision is relevant to its program philosophy, the resilience concept is not quite well illustrated in GPSS program. Additionally, GPSS is the only program which sets specific sustainability science concepts (e.g. resilience, holistic) in its program context. In that respect, GPSS has more specific scope in terms of its conceptual discussion compared to the other two programs.

Table 37. Matrix of Program Philosophy, Mission, and Vision of Three Sustainability Science Programs

	GPSS	LUND (LUCSUS/LUMES)	ASU School of Sustainability
Area of Delivery	1. Overarching theme of the program		
Philosophy	Resilience (short and long terms against changes; e.g. disaster, aging society), holistic, transboundary, and leadership	Transdisciplinary (integration of knowledge from multi-disciplinary to interdisciplinary to transdisciplinary)	Transdisciplinary (adaptive solutions for dynamics of coupled socio-ecological systems)
Additional keywords	Problem solving, experiential learning	Integration of critical and problem solving research,	Sustainability competencies, leadership (design and apply sustainability solution in society)
		action-oriented outreach focus	
Mission	Offer 5-year combined MS and PhD degree based on integrated course;	Create a Centre of Excellence for strong trans-disciplinary research drawing upon the integrated expertise of researchers from LUCSUS and seven disciplines in four faculties;	Create synergies between multiple disciplines that leads to new insight and knowledge;
	Attract students with diverse expertise and cultural background;	Integrate human, social and natural dimensions of sustainability as well as problem solving and critical research strategies for the development of new theory and methodology;	Linking academics and with practitioners in the community who are implementing or looking for sustainability solution;
	Create an international research hub and education network for sustainability, e.g. working with United Nations University (UNU).	Expand the global network of outstanding partners on sustainability research;	Partnership with cities, non-profits and local businesses to provide educational opportunities for students and to provide sustainability thinking to the organizations.
	Provide experiential education through fieldworks and internships;	Provide a range of stimulating and challenging career opportunities for both young and senior researchers;	
	Solving real-world problem and future planning with corporate partners and organizations, e.g. Asian Development Bank, Japan International Cooperation Agency;	Attract major external funding from sources, e.g. the EU Framework Programmes, UNGEF and national research foundations.	
	Enhance university-wide interdisciplinary collaboration, e.g. Graduate School of Frontier Sciences.		
Vision	Graduates that	Program that	Graduates that
	- Develop the skills for global leadership;	- Act as a research platform that advances and problematizes the role of science in the transition toward sustainability;	- Understand the concepts and methods of a number of critical disciplines bearing on the sustainability of systems at different spatio-temporal scales.
	- Acquire a broad perspective and problem solving capabilities;	- Become a major player of integrated knowledge in national and international assessment processes on sustainability.	- Lead others in applying these concepts and methods to developing sustainable strategies for water, land, air, and urban management at the local and global level.
	- Able to apply the concept of resilience both theoretically and practically.		- Lead others in the analysis and design of the built environment and institutions' policies, regulations, and technologies to support sustainable development.
	Program that		
	- Contribute to establishing Sustainability Science as an academic discipline.		

Inputs of three programs

Proportion of designed course work

To examine the inputs of three programs, requirements, compulsory courses, elective courses, and the course categorizations were analyzed. Since each country has its own educational format for higher education, the number of required credits differs greatly among three programs. In order to compare the required amount of work anticipated to complete each degree program, we converted the required credits into clock hour and compared their proportions.

The result illustrates some commonalities and differences as shown in Figure 2. In general, Master's programs have greater proportion in course work that include variety of lecture courses. Some of them include excursions to actual case studies. Doctoral programs, on the other hands, emphasize research work, which is shown as "thesis" component in Figure 2.

About Master's courses, all three programs set greater proportion of required hours for taking lecture courses than that of rest of the courses. It appeared higher in Lund and ASU as 75.0 percent and 85.0 percent of their programs respectively (Figure 2). In the case of GPSS Master's program, it is less at 46.7 percent. In Lund and ASU, the remaining component of their Master's programs was in thesis and research work; 25.0 percent in Lund and 15.0 percent in ASU. Thesis work composes 26.7 percent in the GPSS Master's program while at the same time the program has the third component, "exercise and solution workshop", which composes another 26.7 percent of the total.

In the case of doctoral courses, generally the proportion of the lecture course is less than that of Master's courses across three sustainability science programs. In ASU, the proportion of lecture is still as high as 52.9 percent while the other two programs have less than 25 percent of their requirement credits for lectures (Figure 2). The proportion of thesis work is much greater as it contributes 75.0 percent of doctoral program work in Lund and 60.0 percent in GPSS. One common feature of doctoral courses in ASU and GPSS is the presence of "exercise" course component, which holds the share of 5.9 percent in ASU and 10.0 percent in GPSS. Additionally, there is a component of "leadership" education in GPSS doctoral program, which consists another 10.0 percent of the required credits.

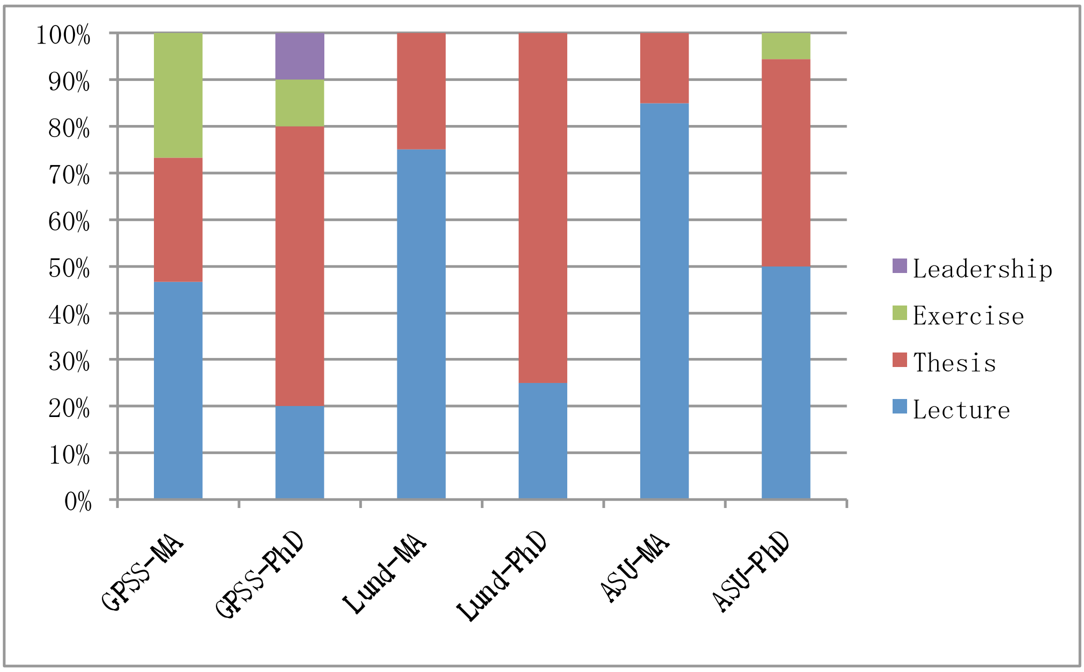


Figure 17. Proportions of required clock hour for obtaining Master's and Doctoral degrees in three sustainability science programs Note: "Exercise" course for ASU corresponds to their "solution workshop" course.

Content of required courses

Aside from the volume of required working hour for Master's and doctoral programs, it is also important to look into the content of offered courses, especially what courses are set as core (or compulsory) courses and elective courses in each program. This is because sustainability science is oriented with interdisciplinary and transdisciplinary approaches, which accommodate different types of knowledge both from diverse academic disciplines as well as society. Having such orientation, it is challenging for program coordinators to determine core courses and elective courses in a sustainability science program. In other words, by examining what courses are set for core courses, it should be possible to know the concentration of each program.

Table 2 shows compulsory and elective courses at Master's level in the three programs. GPSS has only three compulsory courses while ASU has six and Lund has seven courses for their compulsory. Those three compulsory courses in GPSS are separated into introductory course (Concepts and Methodologies of Sustainability Science), socio-environmental system course, and practical research method course (Exercise on Research Methodologies in Sustainability Science). Similar to GPSS, those six compulsory courses in Lund are in three categories, which are introductory course (Sustainability Science), four topical courses which cover system science, social theories, governance, urban and rural systems, and economy, and social implementation course (Knowledge to Action). In case of ASU, compulsory courses are composed of introductory course (Perspectives on Sustainability), two courses on research design and synthesis

(Research Design and Methods for Sustainability, Synthesis of Sustainability Research), system science course (Socio-Ecological-Technical Systems: Domains and Interfaces), and technical and seminal course (Proposal Writing, SOS Community of Graduate Student Scholars). Although the number of courses is different, all three courses have introductory course, system science or system-related course, and methodology courses.

In elective courses, GPSS and Lund have more topical courses while ASU offers more diverse courses on methodologies. In Lund, more of social science concepts are intergraded such as gender, social movements, and societal resilience. In contrast, those topics covered by GPSS elective courses are based more on engineering and planning fields (Table 2). ASU covers GIS, qualitative methods, mathematical concepts and tools. One unique feature of ASU elective is those courses on ethics in sustainability science. They offer three ethic courses in relation to sustainability, engineering, environmental ethics, and policy goals.

The major feature of GPSS is found in fieldwork-based training courses (Global Field Exercise, Exercise of Resilience). In these courses, students are sent to actual case study site of one of the faculty member's research area and conduct various field surveys for the set topics. The duration of these courses is around 10 days to 2 weeks. Students learn about research ethics and fieldwork skills directly from these short-term projects24.

For doctoral courses, all three programs offer only one or two introductory courses. In GPSS, it is an advanced introductory course and the same set of elective courses as Master's is offered. In Lund, only one introductory course is set as compulsory course and it is optional for individual students to take any elective courses. Two introductory courses are set for ASU and advanced topical courses are set for elective courses in ASU such as robustness analysis, modeling for ecology and hydrology, and ecological anthropology (Table 2).

[24] For more information on these fieldwork-based training courses, please see the GPSS website (http://www.sustainability.k.u-tokyo.ac.jp/exercises/#gfe)

Table 38. Requirements, Course Components for Master's Degree

Area of Delivery		Programs: GPSS-GLI	Programs: LUCSUS	Programs: ASU School of Sustainability
5. Curriculum for Master Degree				
Requirement		30 credits (incl. minimum of 4 in Basic Compulsory Courses, 6 in Elective Courses, 8 in Exercise Courses, 8 in Thesis)	120 credits (incl. minimum of 57.5 in Compulsory Courses, 3o in Elective Courses, 10 in Thesis) 120 credits (incl. minimum of 60 in Compulsory Courses, 30 in Elective Courses, 30 in Thesis)	40 credits (incl. 19 in Core Courses, 3 in Methodology Elective, 3 in Methods Elective, 3 in Normative Dimensions of Sustainability Elective, 3 in General Electives, 6 in Thesis)
Compulsory co	1	Concepts and Methodologies of Sustainability Science	Earth System Science	Perspectives on Sustainability
	2	Socio-Environmental System and Sustainability	Social Theory and Sustainability	Research Design and Methods for Sustainability
	3	Exercise on Research Methodologies in Sustainability Science	Sustainability Science	Social-Ecological-Technical Systems: Domains and Interfaces
	4		Governance of Sustainability	Proposal Writing
	5		Urban and Rural Systems and Sustainability	Synthesis for Sustainability Research
	6		Economy and Sustainability	SOS Community of Graduate Student Scholars
	7		Knowledge to Action	
Elective courses	1	Strategies for Global Sustainability	Gender and Sustainability in Theory and Everyday Life	Ethnographic Field Methods or Social Survey Research
	2	Environmental Sustainability	Sustainability and Global Health	GIS for Planners
	3	Management and Policy Studies of Sustainability	Social Movements and Sustainability	Survey Research and Multivariate Statistics
	4	Sustainability of Resources	Energy and Sustainability	Grant Writing for Nonprofit Organizations
	5	Planning and Design for Sustyainability	Water and Sustainability	Qualitative Methods for Sustainability Problems
	6	Education and Sustainability	Societal Resilience	Mathematical Concepts & Tools in Sustainability
	7	Energy and Materials for Sustainabilioty	Science and Politics of Climate Change	Green House Gas Emissions Inventory
	8	Biodiversity	Capacity Development	Climate Action Planning
	9	Environmental Design Studio on Urban Areas	Deciphering Landscape: Understanding the Social and Ecological Dimensions from Multiple Perspectives	Campus Sustainability Planning
	10	Environmental Design Studio on Green Areas		Dynamic Modeling for Sustainability Science
	11	Critical Thinking Basics for Non-Native Speakers of English		Interdisciplinary Writing
	12	Critical Thinking Skills -Applications & Beyond the Basics		Creating your own TED Talk
	13	Frontier of Sustainability Science		Ethics of Sustainability
	14	Exercise on Negotiation, Consensus Building, and Leadership		Sustainability Ethics for Science and Engineering
	15	Global Field Exercise (Field Exercise Course)		Environmental Ethics and Policy Goals
	16	Exercise on Resilience (Field Exercise Course)		

Table 39. Requirement, Course Components for Doctoral Degree

Area of Delivery		Programs		
		GPSS-GLI	**LUCSUS**	**ASU School of Sustainability**
6. Curriculum for Doctoral Degree				
Requirement		20 credits (incl. minimum of 2 in Basic Compulsory Courses, 2 in Exercise Course, 2 in Leadership Exercise Courses, 12 in Thesis)	60 credits in coursework or equivalent	54 credits (with Master's degree, incl. 15 in Core and Challenge Area Courses, 3 in Solution Workshops, 12 in Research, 12 in Dissertation, 12 in Electives)
Compulsory courses	1	Advanced Concepts and Methodologies of Sustainability Science	Introduction to Sustainability Science	Perspectives on Sustainability
	2			Introduction to Research Design and Methods
Elective courses	1	Strategies for Global Sustainability	No elective courses are set.	Transformational Sustainability Research
	2	Environmental Sustainability		Applied Robustness Analysis in Social Ecological Systems
	3	Management and Policy Studies of Sustainability		Qualitative Methods for Sustainability Problems
	4	Sustainability of Resources		Seminar on Stochastic Modeling Ecology and Hydrology
	5	Planning and Design for Sustyainability		Mathematical Concepts and Tools in Sustainability
	6	Education and Sustainability		Sustainable Resource Allocation
	7	Energy and Materials for Sustainabilioty		Ecological (Sustainability) Economics
	8	Biodiversity		Microeconomics of Behavior
	9	Environmental Design Studio on Urban Areas		Science for Sustainability
	10	Environmental Design Studio on Green Areas		Human Dimensions of Sustainability
	11	Critical Thinking Basics for Non-Native Speakers of English		Ecological Anthropology
	12	Critical Thinking Skills -Applications & Beyond the Basics		Sustainability Science: Interactions Between Human and Environmental Systems
	13	Frontier of Sustainability Science		Adaptation, Resilience and Transformation
	14	Exercise on Negotiation, Consensus Building, and Leadership		Industrial Ecology and Design for Sustainability
	15	Global Field Exercise (Field Exercise Course)		Life Cycle Assessment for Civil Systems
	16	Exercise on Resilience (Field Exercise Course)		Science, Technology, and Public Affairs
	17			Uncertainty and Decision Making
	18			Sustainability & Enterprise
	19			Fundamentals of CAS Science
	20			Governance for Sustainability
	21			Environmental Ethics and Policy
	22			Sustainability Ethics for Science and Engineering

Categorization of course contents

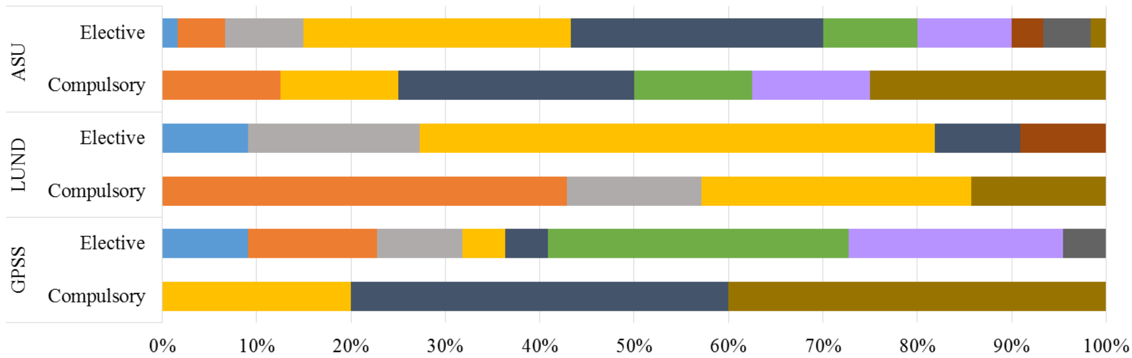
As the third step of course analysis for the input component of the CIPP, we examined the categories of offered courses in three sustainability science programs. The curriculum of three sustainability programs were categorized based on the O'Byrn and his colleagues' method and the categorization list (O'Byrn et al. 2015). The accuracy is maintained by referring the official syllabus guidebooks and also by confirming with the officials in respective programs. Figure 3 provides the summary of compulsory and elective courses combined Master's and doctoral course curriculums.

Firstly in GPSS, compulsory courses are classified in three categories, which are applied sustainability (20 percent), methods (40 percent), and research (40 percent). Among the elective courses, courses in applied work category have the highest share at 32 percent. Arts and humanities category occupies 23 percent of the entire elective courses. These findings suggest that general design of GPSS has its emphasis on methods and research through its compulsory courses and supplementary contents via applied work and arts and humanities by elective course.

Secondly in Lund, general sustainability category has 43 percent of the total share in its compulsory course design. Lund is the only program that has social science courses in compulsory course content, which consists 14 percent of its compulsory. The elective in Lund has the largest share with applied sustainability courses, which shares 55 percent of the entire elective course. Additionally, more courses on social sciences, natural sciences, engineering and business are offered.

Thirdly, in contrast to other two programs, compulsory courses in ASU include applied work and arts and humanities, which occupies about 13 percent of the share, respectively. Compared to Lund, the proportion of general sustainability course is lower, at 13 percent. Methods and research related courses have 25 percent of its compulsory course each. ASU program has among the most diverse set of elective courses, which spread across all 10 categories. Among them, applied sustainability and methods categories have relatively larger shares with 28 and 27 percent respectively.

Overall, it is difficult to identify general trends both in compulsory and elective courses among three programs. This point implies the diverse idea of sustainability science in educational program. One general trend we could possibly elaborate is the smaller share of natural sciences, social sciences, and engineering courses as compared to applied sustainability and methods categories. With this respect, the application of research is more pronounced than gaining of knowledge in these three sustainability science programs.



	GPSS		LUND		ASU	
	Compulsory	Elective	Compulsory	Elective	Compulsory	Elective
Natural sciences	0%	9%	0%	9%	0%	2%
General sustainability	0%	14%	43%	0%	13%	5%
Social sciences	0%	9%	14%	18%	0%	8%
Applied Sustainability	20%	5%	29%	55%	13%	28%
Methods	40%	5%	0%	9%	25%	27%
Applied work	0%	32%	0%	0%	13%	10%
Arts and humanities	0%	23%	0%	0%	13%	10%
Business	0%	0%	0%	9%	0%	3%
Engineering	0%	5%	0%	0%	0%	5%
Research	40%	0%	14%	0%	25%	2%

Natural sciences, General sustainability, Social sciences, Applied Sustainability, Methods, Applied work, Arts and humanities, Business, Engineering, Research

Figure 18. Proportion of Core and Elective Courses

4. Concluding discussion

This study empirically examines the context and the input of three sustainability science programs based on the CIPP framework. The results suggest following two points. Firstly, based on the examination of the context, the main objectives of three programs appeared as nurturing human resource who can contribute to future sustainable society. To achieve this common objective, all three programs emphasize “transdisciplinarity” in their program philosophy. GPSS expresses the similar concept by “transboundary” which stresses interactions among different scales. Problem-based appraoch and co-creation of knowledge with diverse stakeholders are stressed in the program philosophy of those three programs. Secondly, by examining missions and visions of three sustainability science programs, diverse foci of program were identified. The main program interest of GPSS is educational development of sustainabiltiy science. Lund focuses more on research development of the field and establishment of international hub of sustainability research. In contrast, ASU stresses the importance of action-orientation through collaborations with local stakeholders. Course work allocations and course categories also differ among three programs.

To develop the discussions on the context and the input components of sustainability science programs, one of the required discussions is about the linkages among offered courses. While the findings about the course categories suggest that there are generally less volume of natural science, social science, and engineering courses compared to applied sustainability and methods courses. In order to conduct an interdisciplinary research, the skills and knowledge to accomodate multiple disciplinary methods are necessary. Such specific competency to integrate diverse knowledge and methods should be discussed in sustainability science education, especially by examining the interlinkages between topical courses and practicum courses in which studnets directly learn from experiencing case studies.

The second discussion point for program design of sustainabilty science is about the educational development of sustainability science rather than its research development. Inter-/trans-disciplinary appraoch and problem-based appraoch in a resarch project have rich context through actual fieldwork or data analysis process, hence the contextualization of such disciplinary features of sustainabiity science are feasible. In education context, on the other hand, it is challenging to design an educational setting in which students can acquire those practice-oriented features of sustaniability science. One of the possible appraoches to this challenge is to have fieldwork or case study based education, which are taking place in all three programs. For example, GPSS organizes field exercise courses in which students experience and learn actual problems by visiting fields. Yet, the remained challenge is how to evaluate the effectiveness and learning process in such field-based courses in which learning takes place in diverse formats and often through unpredicted patterns.

Lastly, investigating the process of desiging the context and the input of each program is required to make this analysis based on the CIPP framework more comprehensive. Such study can be done by conducting in-depth interviews to the program coordinators of each program. Those collected data should provide rich pictures of program's perspective to sustainability science. The same appraoch can be applied to the process and the product components of CIPP. Especailly the course contents can be analyzed thoroughly by studying the quality of individual course contents. Completion of the CIPP process with such in-depth analysis methods will provide a rich assessment picture of sustinbility science programs. This will be the authors' next contribution to sustainability science education research field.

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Sustainability of the Great Chain of Being

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Abstract

In modern times, Cartesian dualism that explicitly separate subjects and objects, as well as mechanical materialism (e.g., Newtonian mechanics) and element reductionism, has become the mainstream of the science world, thereby accelerating the constant segmentation of academic disciplines. Recently, the trends in the world's scientific and philosophical communities are going beyond skepticism about modernity in the post-Industrial Revolution era and shifting towards the creation of new knowledge appropriate for the postmodern society (postmodern knowledge). However, it is not easy to recombine once-separated disciplines. Although there are some movements to explore theories and methodologies as an integral study, they have not yet led to the creation of "postmodern disciplines."

The objective of this study is to clarify the scope to be covered by "postmodern disciplines" by bringing together the human wisdom accumulated to date. First, we propose an integral framework for the Great Chain of Being by combining modern and postmodern knowledge into the traditional framework of the Great Chain of Being as an human wisdom. Second, we clarify how respective scientific and philosophical communities have perceived the Great Chain of Being based on the integral framework. In this section, we address the issues of Sustainability Science, an important trend in the study of sustainability while we introduce that there is an integral worldview of "descending life," as commonly recognized in a stream of new thoughts and ideas in the recent philosophical community. Finally, we argue that better and integral understanding of the Great Chain of Being is important to the well-being and happiness of individuals and vital to the survival of humans and the earth, and also make suggestions about the methodologies of Sustainability Science.

Keywords: Sustainability Science, Integral Science, Theory of Everything, Post-modernity

Macro-level environmental pressures from Portugal: a multi-disciplinary interpretation of drivers and trends surrounding the national Ecological Footprint

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Abstract

Ecological Footprint Accounting has become an increasingly used metric for natural capital and ecosystem accounting, and is frequently implemented in sustainability studies to provide a first macro-ecological screening of the resource requirements of a society's economy. Introduced by Wackernagel and Rees in the early 1990s, Ecological Footprint is a convenient way to appraise all energy and material flows, in a common basis and compare them with a reference benchmark, the biocapacity, to derive indications of the extent to which human activities exceed the ecosystems' capacity to provide key life supporting services. Such screening possibly allows understanding where and how human pressure can be reduced. In this paper we aim to apply Ecological Footprint Accounting to the case of Portugal and assess demand for renewable resources and ecological services (aka Ecological Footprint) of Portuguese residents and then compare this demand with that of other countries as well as with average availability of such resources and services at global, Mediterranean and National levels. Results indicate that, as of 2012, Portugal had the 8th highest per capita Ecological Footprint among the 24 considered Mediterranean countries, at 3.9 global hectares (gha) per capita. Meanwhile, Portugal per capita biocapacity in 2012 was approximately 1.5 gha per capita, slightly higher than the Mediterranean regional average (1.3 gha per capita) but lower than the world average value of 1.7 gha per capita. Over the period 1961-2012, Portugal's Footprint increased by approximately 70% (from 2.3 to 3.9 gha per person): the highest rate of increase was found in the second half of the '80s and mainly driven by an increase in the demand for cropland-based resources and forest's carbon sequestration capacity due to the increased demand for energy, fossil fuels and energy intensive manufactures goods and services. The National biocapacity increased by 20% (from 1.3 to 1.5 gha per capita) over the same period. Aiming to provide a multi-disciplinary interpretation of drivers and trends surrounding the national Ecological Footprint evolution, we investigate here, from a political science point of view, the main changes in the socio-economic and environmental context as well as the main environmental and socio-economic policies implemented in Portugal over the considered period. A qualitative assessment of how these policies and context changes may have affected the Footprint trend will be provided. Finally, socio-economic data for Portugal are also collected and used, together with Footprint results, to assess Footprint drivers and mitigation opportunities. This may start up an interdisciplinary focal point aiming at following up and periodically reporting on the developments of the Portugal's various sector and resource footprints, be it at national or city level.

Keywords: Footprint trends; society metabolism; geopolitical interpretation.

A review of commitment and implementation of Sustainable Development in Higher Education: Results from a worldwide survey

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Abstract

During the last two decades, many higher educational institutions have become involved in embedding sustainable development into their academic systems. The research for this paper was built upon discussions on declarations, charters, and other initiatives designed to commit their institutions to education for sustainable development. It analyses if such commitment leads to more sustainable development implementation within the academic institution. The research was performed using a survey, based upon a literature review of 60 peer-reviewed papers. The survey was divided into eight categories: background; institutional framework; campus operations; education; research; outreach and collaboration; on-campus experiences; and assessment and reporting. The survey was answered by 84 respondents from 70 institutions, worldwide. The responses were analysed via descriptive analysis, grounded theory, and inferential statistics. The results revealed that there were many examples of sustainable development implementation throughout the system; however, generally the efforts tended to be compartmentalised. The analyses also highlighted strong linkages between the institution's commitment to sustainability, implementation, and signing a declaration, charter, or initiative. The findings suggested that academic leadership's commitment was a leading cause for signing a declaration, charter, or initiative, and implementing sustainable development. The research team provided recommendations for higher educational leaders, including acknowledge that the higher educational institution system is comprised of several inter-related elements; commit to sustainability by integrating it into policies and strategies; show the commitment by signing a declaration, charter, or initiative; establish short-, medium-, and long-term plans for its institutionalisation; and ensure that sustainable development is implemented throughout the system.

Theme 1 posters

Environmental Evaluation of Six Building Shearing Layers for the Allocation of Green Points

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Abstract

Categories and credits in green rating systems usually contain building design requirements for a range of design times, i.e., short lifetime expectancies and long environmental impacts. Therefore, green certification is primarily achieved by correctly sizing mechanical and electrical systems with short lifetime expectancies, whereas effective bio-climatic and passive solar architecture strategies with long lifetime expectancies are neglected. Life cycle assessment (LCA) is a methodology that allows an environmental evaluation to be performed. The objective of this study is to suggest a methodological LCA evaluation of six shearing layers, Site, Structure, Skin, Services, Space, and Stuff, to improve sustainable performance under green rating systems. The shearing layers were evaluated by Eco-indicator 99 (EI99) for a typical five-story office building. The results of this study can allow rating systems to more intently and realistically handle building and system lifetime expectancies and different environmental damages.

Keywords: Green rating system, Sustainable design, LCA, Shearing layer concept, Passive solar architecture

1. Introduction

Green rating systems consider several similar sustainable categories, such as Site, Energy, Water, Materials, Emissions, and Management. However, categories and credits typically contain building design requirements for both long lifetime expectancies, i.e., long environmental impacts, and short lifetime expectancies, i.e., short environmental impacts. Therefore, green certification is primarily achieved by correctly sizing mechanical and electrical systems, improving building envelope insulation, and implementing on-site renewable energy measures, whereas effective bio-climatic and passive solar architecture strategies are neglected (Shaviv, 2008).

However, the division of the energy category into two subcategories, i.e., "building energy performance", which considers only bioclimatic and Passive and Low Energy Architecture (PLEA) aspects, and "building service systems", which includes heating, ventilation, and air conditioning (HVAC), other mechanical systems, solar water heating, and passive Photovoltaic (PV) systems, has already been implemented in the revised the Israeli Green Building Standard (SI5281, 2011).

Furthermore, Pushkar and Shaviv (2013) proposed adopting the "shearing layers" concept (originally invented by architect Frank Duffy) in green rating systems to consider building and service lifetime expectancies. According to this concept, an entire building can be separated into six different timescale layers: Site (eternal), Structure – the foundation and load-bearing elements (fifty to three hundred years), Skin – exterior surfaces (twenty to fifty years), Services – communication wiring, electrical wiring, plumbing, fire sprinkler systems, HVAC, elevators and escalators (ten to twenty years), Space plan – interior walls, ceilings, floors, and doors (three to ten years), and Stuff – chairs, desks, phones, pictures, kitchen appliances, lamps, and hairbrushes (daily to monthly) (Brand, 1994).

According to Pushkar and Shaviv (2013) the visualization of a building as six shared layers (Site, Structure, Skin, Services, Space, and Stuff) was derived from the suggestion that each of the sheared layers reflects a different lifetime scale and therefore different environmental damages. Based on this suggestion, the authors developed a method for the allocation of green points with accordance to the SI5281 (SI5281, 2011), Sustainable Building Tool (SBTool, 2012), and

Leadership in Energy and Environmental Design (LEED, 2009) systems. It was concluded that applying the shearing layer concept to green systems will result in more reliable procedures for the allocation of green points.

However, “with the current push toward sustainable construction, LCA has gained importance as an objective method to evaluate the environmental impact of construction practices” (Singh et al., 2011). Life cycle assessment (LCA) is a complete ‘cradle to grave’ methodology that considers the entire life cycle from raw material acquisition to final disposal. Thus, the LCA of the shearing layers should be evaluated prior to the allocation of green points. Consequently, the primary objective of this study is to perform an LCA of six shared layers, Site, Structure, Skin, Services, Space, and Stuff, in order to develop a more reliable allocation of green points for current green rating systems.

2. Methods

The six shearing layers (Site, Structure, Skin, Services, Space Plan, and Stuff) were evaluated by Eco-Indicator 99 (EI99) (Goedkoop and Spriensma, 2001) for a typical office building. EI99 consists of six methodologies: egalitarian/egalitarian (e/e), egalitarian/average (e/a), hierarchist/hierarchist (h/h), hierarchist/average (h/a), individualist/individualist (i/i), and individualist/average (i/a). These options can be classified as perspective-specified (e/e, h/h, and i/i) and perspective-averaged (e/a, h/a, and i/a) sets.

This study assumes that the building layers for an entire building are grouped into the Building layers (i.e., Site, Structure, and Skin) and the Service layers (i.e., Services, Space Plan, and Stuff). A five-story building (42 m × 42 m × 15 m with a floor area of 7,740 m^2) was used in this study. Table 1 lists the components considered for each layer. Reinforced concrete technology was assumed. The building materials considered for each of the building components: foundation, columns, partitions, beams, floor/ceiling, floor coverings, wall type, and wall coverings were evaluated.

Table 1. Components of six shearing layers.

Building layers	Components
Site	Excavation and landfill
Structure	Foundations, columns, beams, and ceilings
Skin	External walls, external wall covering, roof, roof covering, and glazing
Service layers	Components
Services	HVAC, elevator, electrical fixtures, and plumbing fixtures
Space Plan	Partitions, floor coverings, and doors
Stuff	Computers, prints, furniture, and lamps

The environmental inventory analysis for the six layers was conducted using the SimaPro (SimaPro v.7, 2011) database tool. A two-step calculation procedure was performed: environmental evaluation and statistical analyses. Initially, the EI99 tool was used to calculate the environmental scores (Pt) associated with the six building layers. Thus, six EI99 environmental scores (e/e, e/a, h/h, h/a, i/i, and i/a options) were evaluated for each considered layer (Site, Structure, Skin, Service, Space Plan, and Stuff). Then, these layers were compared by applying an unpaired two-tailed t-test.

Site. Only excavation and landfill were considered. The transport distance of material/product from a building site to a disposal site vary from one material/product to another and is influenced by the method of disposal (e.g., landfill disposal, incineration or reuse). A minimum transportation distance of 50 km was assumed from the building site to a disposal site. The American manual “Means Man-Hour Standards for Construction” (Mahoney and Cleveland, 1988) was used to calculate the number of excavation hours. Equipment power data were acquired from the Southern-Tool Tool Catalog. Environmental scores were calculated based on coal-based French technology (Israel electricity production data were not available in SimaPro).

Structure. In Israel, load-bearing building components are usually constructed with reinforced concrete technologies. Environmental evaluations were conducted for all components of the Structure layer (Table 1) for two life cycle stages: production and construction (P&C) and maintenance to demolition (MtoD). The entire building lifetime was assumed to be 50 years. Because the timescale of the Structure layer (50 years) and the life cycle of the whole building were the same, only the demolition portion of MtoD was taken into account.

Skin. Environmental evaluations were conducted for all components of the Skin layer (Table 1) for three life cycle stages: P&C, operational energy (OE), and MtoD. It was assumed that the building is constructed in a heating-dominated climate with a mild summer and cool winter (represented by Jerusalem’s Typical Meteorological Year). Occupancy hours from Sunday to Thursday are 7:00 to 18:00. The air infiltration causes a 0.5 h-1 air change rate. Heating and cooling are by means of a heat pump (coefficient of performance (COP) for heating – 2.75 and for cooling – 3.0), with set-points of 20 °C and 24 °C, respectively. The design level for electric lights was 360 W (this design level corresponds to a lighting level of 500 lux), for electric equipment, 250 W, and for occupants, 1 person with an activity level of 100 W. Clothing assumed 1 Clo in winter and 0.5 Clo in summer. Window area was assumed to cover the minimum value, 8% of the floor area. Low-Emissivity glass (LoE Clear) was used in this study. Analysis was performed for a building design life of 50 years.

Services. Environmental evaluations of the components (Table 1) were conducted for the P&C and MtoD stages. However, for the elevator, the operational OE stage was also considered. The maintenance and demolition stages occur many times over a building’s lifetime for all of the investigated components of the Services layer. That is, in this case the maintenance and demolition stages were studied as a combined MtoD stage. The service life of the elevator and HVAC systems was suggested to be 15 years, while the service life of electrical and plumbing fixtures was assumed as 10 years.

Space Plan. Environmental evaluations were conducted for all components of the Space Plan (Table 1) layer for two life cycle stages: P&C and MtoD. In MtoD stage only cleaning and demolition procedures were considered. For example, the floor coverings in office buildings should be cleaned every day of the work week. Thus, a cleaning rate of 240 times per year was used as an appropriate washing rate for the building floor coverings. The timescale of marble floor coverings is as long as the entire lifetime of the building. Therefore, this component was only destroyed (without replacement) at the end-of-life stage of the building.

Stuff layer. Environmental evaluations of were conducted for all components of the Stuff layer (Table 1) for two life cycle stages: P&C and MtoD. In contrast to the daily to monthly timescale suggested by Frank Duffy, in this study a more reliable service life of 5 years for the Stuff layer was considered.

Experimental design. The experimental design of the present study refers to a “single-unit design structure.” First, one paring of layers, Building layers and Service layers, within the whole building frame was analysed. Then, three pairings of Building layers (Site, Structure, and Skin) were analysed. Consequently, three pairings of Service layers (Services, Space plan, and Stuff) were analysed. The analyses were presented by means of a confidence interval (CI), a P-value, and effect size (ES). Each of the layers was defined as a treatment structure. Environmental damage was defined as a response structure. The methodological options of EI99 (i/i, h/h, and e/e and i/a, h/a, and e/a) were defined as three experimental units. Hurlbert and Lombardi (2009) advocated that 80% CI is an acceptable level of CI to not accept the hull hypothesis. Therefore, it was suggested that the mean of three options of EI99 (i.e., sample size (n) is n=3) at 80% CI and higher can be considered as the true value.

Statistical analysis. When a sample size has n < 5, then using both standard deviation (SD) and standard error (SE) for calculation of the dispersion about the mean is meaningless (Beninger et al., 2012). In the present study, the sample size (n) in any pairing's groups is n1 = n2 = 3. The sample size is limited due to the availability of only three independent methodological options of EI99 (i/i, h/h, and e/e and i/a, h/a, and e/a). Consequently, the values are expressed as the mean ± margin of error (ME). The ME was calculated at three levels: 80% CI, 90% CI, and 95% CI. The ME was defined as half the width of the CI.

Data sets were divided by 106 prior to analysis. An unpaired two-tailed t-test was used to compute the difference between all pairings of the layers. Before using the t-test, the Fisher-Snedecor F-test was used to confirm equal variability. Satterthwaite's approximate t-test was performed if variances were not confirmed to be equal. Neo-Fisherian significance assessments were used to interpret the signs and magnitudes of the statistical effects. Following Hurlbert and Lombardi (2009), the P-values were evaluated according to three-valued logic: "it seems to be positive" (i.e., there seems to be a building layer difference), "it seems to be negative" (i.e., there does not seem to be a building layer difference) and "judgment is suspended" regarding the building layer difference. In addition, Effect size (Cohen's d-test) was also used to help in distinguishing the three-valued logic. For example, when the sample size is n1 = n2 = 3 then the difference between two means can be accepted if effect size ≥ 6.0. The results were presented as a Mean ± ME.

3. Results

Table 2 shows a comparison between two types of layers, Building layers and Service layers, evaluating both sets of EI99 methodological options, perspective-specified (i/i, h/h, and e/e) and perspective-averaged (i/a, h/a, and e/a). Under both sets of methodological options, the environmental damage associated with Building layers was higher than the environmental damage associated with Service layers. Under both sets of methodological options, the CI for Building layers was established at 95%, while for Service layers it was set at 90%. The judgment about the difference between Building layers and Service layers should be suspended because the ESs are not large enough (i.e., < 6.0) when the extremely small sample sizes (i.e., n = 3) are evaluated.

Table 2. Average perspective-specified methodological options of EI99 (i/i, h/h, and e/e) and perspective-averaged methodological options (i/a, h/a, and e/a) of EI99 for both Building and Service layers as a function of the environmental impact in 106 Pt. P is P-value, ES is effect size, ME is marginal error, CI is confidence interval, n is sample size.

Type of Building layers	Mean ± ME	ES	P
Perspective-specified methodological options (i/i, h/h, and e/e)			
Building layers, n = 3	3.6648 ± 0.9440 at 95% CI	2.85	0.0252
Service layers, n = 3	1.6335 ± 1.5766 at 90% CI		
Perspective-averaged methodological options (i/a, h/a, and e/a)			
Building layers, n = 3	3.7313 ± 2.0119 at 95% CI	2.79	0.0269
Service layers, n = 3	1.4829 ± 1.3548 at 90% CI		

Table 3 reflects a comparison among three layers (Site, Structure, and Skin) within Building layers, evaluating both sets of EI99 methodological options, perspective-specified (i/i, h/h, and e/e) and perspective-averaged (i/a, h/a, and e/a). Under both sets of methodological options, a ratio of the environmental damages among the three layers within Building layers was represented as 1:10:100. In those three layers the CI was established at 95%.

If environmental damage is evaluated by applying perspective-specified methodological options, then the difference between the Site layer and Skin layer, as well as the difference between the Structure layer and Skin layer, seems to be positive. The judgment about the difference between the Site and Structure layers should be suspended. However, if environmental damage is evaluated by applying perspective-averaged methodological options, the difference between the Site layer and Structure layer seems to be positive. The judgment about the difference between the Site layer and Skin layer, as well as the difference between the Structure and Skin layers, should be suspended. This is because the ESs are below 6.0 when the extremely small sample sizes (i.e., n = 3) are evaluated.

Table 3. Average perspective-specified methodological options of EI99 and perspective-averaged methodological options of EI99 for three Building layers as a function of the environmental impact in 106 Pt. P is P-value, ES is an effect size, ME is marginal error, CI is confidence interval, and n is sample size.

	Site, n = 3	Structure, n = 3	Skin, n = 3
Perspective-specified methodological options (i/i, h/h, and e/e)			
Mean ± ME	0.0373 ± 0.0148 at 95% CI	0.3156 ± 0.2990 at 95% CI	3.3118 ± 0.7974 an 95% CI
Building layers	Site	Structure	Skin
Site	X	ES=3.27 P=0.0567	ES=14.42 P=0.0032
Structure		X	ES=12.36 P=0.0001
Skin			X
Perspective-averaged methodological options (i/a, h/a, and e/a)			
Mean ± ME	0.0384±0.0249 at 95% CI	0.3142±0.0758 at 95% CI	3.3787±2.0275 an 95% CI
Building layers	Site	Structure	Skin
Site	X	ES=12.14 P=0.0001	ES=5.78 P=0.0193
Structure		X	ES=5.31 P=0.0227
Skin			X

Table 4 reveals a comparison among three layers Services, Space Plan, and Stuff) within the Service layer, evaluating both sets of EI99 methodological options, perspective-specified (i/i, h/h, and e/e) and perspective-averaged (i/a, h/a, and e/a). Under both sets of methodological options, the environmental damage among the three layers has a ratio of 100:1:10 for the System, Space plan, and Stuff layers, respectively. The judgment about the difference between the layers Services and Space Plan, between Services and Stuff, and between Space Plan and Stuff should be suspended. This is because the ESs are not large enough (i.e., < 6.0) when the extremely small sample sizes (i.e., n = 3) are evaluated.

Table 4. Average perspective-specified methodological options of EI99 and perspective-averaged methodological options of EI99 for three Service layers as a function of the environmental impact in 106 Pt. P is P-value, ES is an effect size, ME is marginal error, CI is confidence interval, and n is sample size.

	Site, n = 3	Structure, n = 3	Skin, n = 3
Perspective-specified methodological options (i/i, h/h, and e/e)			
Mean ± ME	1.1882 ± 0.7784 at 80% CI	0.0820 ± 0.0084 at 95% CI	0.3633 ± 0.2378 at 80% CI
Service layers	Service	Space Plan	Stuff
Services	X	ES=2.18 P=0.1156	ES=1.56 P=0.1285
Space Plan		X	ES= 1.82 P=0.1553
Stuff			X
Perspective-averaged methodological options (i/a, h/a, and e/a)			
Mean ± ME	0.9993±0.9302 at 90% CI	0.0809±0.0391 at 95% CI	0.3056±0.2842 at 90% CI
Service layers	Service	Space Plan	Stuff
Services	X	ES=2.35 P=0.1020	ES=1.70 P=0.1057
Space Plan		X	ES=1.88 P=0.1461

Stuff			X

4. Discussion

This paper presents the application of the three perspective-specified methodological options (i/i, h/h, and e/e) along with the three perspective-averaged methodological options (i/a, h/a, and e/a) of EI99 to six shearing layers, i.e., Site, Structure, Skin, Services, Space plan, and Stuff, for a more reliable point allocation for green rating systems. Under both perspective-specified and perspective-averaged environmental evaluations, the Building layers have higher priority (70%) than the Service layers (30%).

The obtained environmental differences between the Building and Service layers confirm the following idea suggested by Shaviv (2011): “As the life expectancy of a building in Israel is about 50 to 100 years and that of the building systems is about 15 to 20 years only, the requirements for these two groups of the energy sub-categories should differ...” This requires more attention to the Building layers, which are responsible for bioclimatic and PLEA effects, allowing a large number of points to be achieved for these layers. The results are also in accordance with the results presented by Pushkar and Shaviv (2013). The authors applied the shearing layer separation procedure to all generic environmental categories of green rating systems such as energy, site, water, material, H&WB, and innovation. It was concluded that SI5281 already fits the shearing layer concept very well because of the increased priority of Building layers (60%) and decreased priority of Service layers (40%).

5. Conclusions

The present study is not intended to be a comprehensive LCA case study. The primary goal of the study was to suggest an LCA framework application for the environmental evaluation of six shearing layers (Site, Structure, Skin, Services, Space and Stuff).

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Measuring Sustainability in Higher Education Institution: a case study in a university in South of Brazil

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Abstract

The global development has changed the world in the last centuries in a way that environmental disasters are getting common. Many organizations, public and private, have been discussing about necessary changes in order to meet "the needs of the present without compromising the ability of future generations to meet their own needs" (WCED, 1987), defining what sustainable development is. Organizations need to develop themselves towards sustainability, needing therefore qualified professionals and many of them come from a university. In this way, Higher Education Institutions (HEI) are relevant to influence and change the society, not only to teach about sustainability, but also to manage the institution itself in a sustainable way. In Brazil, sustainability is since 2012 part of the National Curriculum Directive for Environmental Education (Brazil, 2012), so HEI have to include sustainability in their courses. Showing its commitment with sustainability, some HEI in Brazil have also engaged with the Global Compact, Sustainable Development Goals and/or PRME. Teaching sustainability and committing to these global initiatives could reflect that these HEIs are involved with the topic, but the question is how committed are these universities in fact. Do they only teach, or do they also sustainably manage the HEI? With this focus in mind, a qualitative case study is proposed to evaluate if a university also merge sustainability in its management. Therefore a university in south of Brazil was selected for the study, as this HEI is one of the leading universities in Brazil, is the first in Brazil on citation ranking according to THE World University Rankings, has around 30,000 students in 4 camps in Paraná State, and is also signatory of Global Compact. With the support of a selected indicator of sustainability in higher education called STARS, several interviews are held in this HEI with relevant organization members, are analysed with software Atlas.ti, so this give support to identify the necessary topics of this indicator. As result, it is possible to identify that some topics are in practice in this HEI, especially when it comes to the engagement with the community through voluntary work. When it comes to a general overview, board of directors are more focused on making the university internationally recognized, but not necessarily on making it sustainable for next generations. This result is positive in the sense of comparing the results with other institutions that use this indicator and supporting the HEI to put a target on HEI sustainability development. In the other way, this result bring new light on sustainability on HEI, as being a signatory of diverse sustainability initiatives doesn't mean that the university is actually engaged with this.

Keywords: HEI, indicator in HEI, STARS, Brazil

1. Introduction

Sustainability is a concept that in fact has its origin some centuries ago (Boff, 2012) and is since last decades more developed due to an interest of society after several environmental disasters. This led to the Brundtland definition that sustainability development "meets the needs of the present without compromising the ability of future generations to meet their own needs" (WCED, 1987).

Several organizations, private and public have committed to sustainability and need therefore professionals that understand and think of new ways to make their company, society and environment more sustainable. An important part of these professionals comes from universities, here also called Higher Education Institutions (HEI), and need knowledge about sustainability and how to bring sustainable results to their companies.

According to Amaral et al. (2015), “higher education institutions have a special social responsibility on the society development, particularly on the education of future leaders and on the proliferation of public awareness about sustainability”, serving as the training grounds for future leaders” (White, 2014). In a step further, superior education have the responsibility to create (or improve) the basis, so society reach a sustainable future (Cortese, 2003).

In Brazil the National Curriculum Directive for Environmental Education (Brazil, 2012) establishes that Brazilian HEI have to include sustainability in their courses. In addition, some of HEI have joined international initiatives on sustainability, such as Global Compact, Sustainable Development Goals and/or PRME.

Following the National Curriculum Directive for Environmental Education , many HEI in Brazil have sustainability disciplines in their curricula for undergraduate courses, some others have graduate group studies in sustainability, which shows that Brazilian universities are either adapting their courses to the Brazilian Directive (in case of undergraduation), or researching sustainability (in case of graduation). However, as one of the targets of an HEI is to educate future leaders, preserving and refining “existing knowledge while producing, disseminating, and applying new knowledge” (Waheed et al., 2011), universities have the challenge to manage the HEI in a sustainable way, applying a tool that evaluate management inside the HEI (Shriberg, 2000).

Even engaging to the international initiatives and teaching sustainability, almost no HEI in Brazil have a sustainability target and therefore apply no indicator related to the topic. For this reason, the proposed case study aims to evaluate how a HEI signatory of Global Compact is when it comes to sustainability.

The selected HEI is located in south of Brazil and is well recognized in the country. It is a private university with around 30,000 students in 4 camps, has a total of 8 schools, 60 undergraduate courses and 28 graduate courses. In 2015 THE World University Rankings recognized this institution as first in Brazil on citation. It shows that this university is on track of it’s target to be a world class university by 2022 (PUC-PR, 2015). Also, this HEI is signatory of the Global Compact.

The evaluation of the referred HEI is possible with the STARTS indicator of sustainability in higher education. Based on selection criteria, this indicator was the guidance for the research done in the university.

2. Methods

Universities in Brazil are still engaging on sustainability, and this engagement does not include the evaluation whether the universities are sustainable or not. To be possible to do such evaluation, an indicator is used. With a big number of indicators available, firs it was necessary to define which one was the most suitable for this research.

According to Bellen (2006, p.42), “the target of an indicator is to aggregate and quantify information in a way that its significance become more visible”. For an indicator to be useful, its importance has to be clear, as the decision-making management will use it (Galoppín, 1996).

For Rametsteiner et al. (2011), sustainability indicators have as main target the structuring and communication about relevant topics for a sustainable development. The United Nations brings relevant topics about indicators of sustainable development, such as better decision-making and better communication about values, thoughts and ideas (United Nations, 2007). Following the establishment of a sustainability indicator, rankings can be organized and the comparison of organizations, regions or even countries can be done. This can motivate managers to be part of rankings, showing their interest on sustainability (Dahl, 2012).

Sustainability indicators for universities use to evaluate camps, curriculum, students’ performance towards sustainability (Cole, 2003; Vaz et al., 2010; Ciurana e Leal Filho, 2006). These indicators can also include the HEI evaluation as an organization (Lozano, 2006; White, 2014), including further aspects as the triple bottom line.

The choice of an indicator to be used on a university evaluation is crucial, as this evaluation should support the HEI managers on taking right decisions towards sustainability. Besides this, there are several indicators available (Shriberg, 2002; Cole, 2003; Yarime and Tanaka, 2012) and the choice should be justified. To select an indicator, the proposed category analysis are scope, field, data, participation and interface (Bellen, 2006).

With this methodology, several indicators were evaluated, such as AISHE, SAQ, STARS, Penn State Indicator Report, CSAF, CSAF Core, USAT, GSAU, AUA, National Wildlife Federation's State of the Campus Environment. Some others weren't find to be part of the analysis. STARS is the indicator with more categories fulfilled and is therefore suitable as a path to check the sustainability at the university. A case study is performed at the chosen HEI to evaluate the sustainability with STARS indicator. With very few secondary data available, relevant organization of this HEI are interviewed. After this, interviews are analysed with support of software Atlas.ti, so necessary topics of this indicator can be identified.

The indicator STARS (STARS, 2016) is divided in 5 big groups which are: academics, engagement, operations, planning & administration, and innovation. Below is the description of these groups and analysis.

In the first group academic, is verified topics such as number of courses offered in sustainability, sustainability degrees, immersive sustainability-focused educational study program, students assessment about sustainability, incentives to develop new courses with sustainability focus, existence of a living laboratory for sustainability, research about sustainability, procedures to recognize interdisciplinary, transdisciplinary and multidisciplinary approaches.

In the second group, engagement is asked if students have focus on sustainability related to a number of activities during the period the student is on HEI; if the university gives any information about sustainability to the students, staff or faculty. It is also asked if there is any outreach campaign with students; involvement of staff on topics related to sustainability, either by education / training or by orientation. There are also questions related to the engagement with stakeholders, sustainability partnership and community service.

The third group operations asks about detailed information regarding air & climate, buildings, energy, water, purchasing, transportation, among others. Target it that the university measures and work to reduce its greenhouse gas and pollutant emissions. This group of questions is very detailed and for some HEI it might be difficult to have all data available.

In the fourth group planning & administration, the management of HEI is evaluated. To choose this indicator STARS, this topic was very important. This group indicates the depth on which the university is institutionalizing sustainability and including sustainability in the future vision of the institution (STARS, 2016).

The last group innovation refers to the HEI search for new solutions and processes towards sustainability. On this topic is possible to point out improvements and changes on the processes at the university, which don't have to be organized or implemented by a specific department, but by all organization.

With these five groups of questions, the target is that the university can evaluate itself in several aspects. Results can give direction to help defining vision and goals that the university should achieve to be more sustainable.

Having a good indicator, the target of this case study is to evaluate the sustainability at the specific HEI. It's not possible to generalize the results to other universities, but is one of the first's steps on HEI sustainability evaluation in the country.

3. Results and Discussion

Aiming to bring new light in research about sustainability in HEI, a university located in south of Brazil is evaluated with a sustainability indicator for HEI to verify if the engagement this university shows by signing the Global Compact and by teaching sustainability can be verified on its management.

Indicator for HEI STARS is used. Several interviews are necessary to gather information from this university. Software Atlas.ti is used to perform the analysis and consolidate of relevant topic related to the study.

The first group is about academics and include two smaller groups, one about curriculum and one about research. At the researched university, inclusion of sustainability in undergraduate courses can be seen only in some of the courses, such as business administration, architecture and environmental management. For graduate, sustainability is included in courses such as business administration, urban management, law and cooperative management. None of these courses, undergraduate and graduate, offer a certificate about sustainability. Although this amount of courses engaging in sustainability, a global evaluation about this topic that comprises students is not performed. The offer of sustainability courses is more difficult on undergraduate courses in Brazil, because disciplines are fixed for some years. Nevertheless, the offer of sustainability courses is open in graduate courses. Professors can offer disciplines about sustainability any time, as soon as the demand is realized. From the interview, it can be pointed out that professors working on research departments are more connected with sustainability research, except for the medical departments.

Campus as a living laboratory is also one of the topics. During the interviews, it was not identified that the HEI is connecting sustainability with the campus. As one of the professors says: “what we have here is relatively worse than the sustainability topics, the actions are very seasonal”. The point related to usage and recognition of interdisciplinary, transdisciplinary and multidisciplinary was good evaluated by all professors interviewed.

In the second group engagement, students should be involved in sustainability activities that are not in the regular classroom program. The responses of interviewed managers show that the HEI is more involved with social activities. This point was observed on Theology graduation course, but mainly on Communitarian Project. All students on this HEI have to work 30 hours as voluntary in several communitarian projects throughout the time they have in the university. They have orientation from the university and from the NGO (non-governmental organization) that they choose to be voluntary.

Communication of actions and information to the staff, faculty or students is not effective. Few of the interviewed could recall of specific mailing to inform faculty to turn off the light when leaving the classroom. Folders and other kind of communication were not pointed out by the interviewed. The university doesn’t offer outreach campaign about sustainability to neither students nor employees. Orientation of new employees was not checked, as the hiring and trainings are done by a different organization that maintain the university.

Related to the collaboration to other institution, so that this HEI become more sustainable, one of the interviewed answered that the university itself does not have, but the schools inside the HEI might have specific collaboration related to research. Connections with government are established with the energy company to reduce energy consumption and to establish some projects, and with the city hall to fight pollution on the river that flows on the university.

The third group operations questions about all operational topics from the university. At the researched HEI, all operational services are centralized with the organization that maintain the university. The HEI itself has no control of the air quality; building operations, maintenance, design and construction; food and beverage purchasing (outsourced recently); dining; energy (consumption and renewable); landscape management; biodiversity; purchasing; life cycle cost analysis, guidelines for business partners and waste management.

Regarding transporting, a group of professors at the HEI did some years ago a report about the transportation at the university. The ideia was to influence more students and employees to use bicycle by offering proper infrastructure. This initiative survived for 2 weeks. The university reorganized its infrastructure to give back place to cars.

The fourth group planning & administration is divided in 4 smaller groups: coordination, planning & governance; diversity & affordability; health, wellbeing & work; and investment. To answer the first small group coordination, planning & governance questions, a sustainability coordination department does not exist, there is no sustainability target implemented at any of the schools. Nevertheless, it was identified that in all schools interviewed, including undergraduate and graduate courses, students and faculty participate actively in governance process.

For the subgroup diversity & affordability, there is no committee to encourage the diversity, or to train employees about equity and diversity. However, the university has a group to support students with different kinds of difficulty. This group was mentioned by all HEI interviewed, which shows that this group has a good outcome of supported students. Regarding the question whether the university has a discrimination committee, there were ambiguous answers. Some interviewed answered that there is no such committee, but others answered that there are 2 groups that could support, one the communitarian rectory and other the human rights group. About the accessibility and affordability of low-income students at the university, the HEI offers not only a scholarship from the state (which in Brazil is possible to get in every private university), but also scholarship from the university. Especially for the graduate courses, it could be verified that in all interviewed courses a minimum of 70% of students receives either a scholarship, or don't have to pay for the course.

For the subgroup health, wellbeing & work, there is no wellness program to the employees, although a fitness centre is available to all employees and to the students. It could not be verified if employees participate of any survey or evaluation to measure employee satisfaction. If the employees receive a sustainable compensation could also not be checked.

In the last subgroup investment, no point related to an active committee on investor responsibility body and a sustainability investment was verified.

The last group innovation seeks for processes improvement and innovative solutions. The researched HEI supports innovation, but has no structured process, regulation or motivator for this. Employees can improve the process on which they are connected, but no promotion or salary increase is offered.

4. Conclusions

Sustainability applied to universities in Brazil is a recent topic. Some HEI are currently engaged in sustainability from the curriculum and teaching point of view, and very few are applying sustainability concepts on its management. Therefore the analysis of this topic with an indicator on a chosen HEI in south of Brazil is relevant to bring new light in research.

The researched university has 30,000 students divided in a total of 8 schools. These schools offer 60 undergraduate courses and 28 graduate courses. The HEI is also recently recognized as the first on citation ranking. Being signatory of the Global Compact and having the target to be a world class university by 2022, this university was chosen for this case study.

Due to several criteria established, STARS indicator was used to guide the research at the selected HEI. This indicator is already used by several universities in the US, Canada, Europe and Asia. In Brazil, no university so far used this indicator to report their sustainability status.

The indicator is divided in 4 big groups: academics, engagement, operations, planning & administration, and innovation. The institution has some sustainability disciplines offered to the students, but no course for this topic and no sustainability certificate is therefore given. The HEI applies interdisciplinary, transdisciplinary and multidisciplinary methodologies, but not with a sustainable focus or support.

Students are involved in communitarian voluntary projects during 30 hours during their entire time at the university. It might be seen as few hours, but in Brazil this practice is not common, which is a great advantage for the students and the HEI. Diversity and discrimination are points that can be encouraged by the university to be followed and taught, as for most of undergraduation students it will be the last step before they enter in the labour market. Scholarship is a positive point of this university, especially for the graduate students.

Sustainability communication at the university can improve a lot. Also the group operations should receive more attention from the university and students could be involved to improve processes and standards inside the university. They could learn from practical initiatives.

The researched HEI could create a sustainability committee to define, develop, implement and track action towards sustainability. This department could also support the vision to be a world class university.

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NETGREEN – Network for Green Economy Indicators

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Abstract

The discussion on how to place the global economy on a more sustainable path has intensified in recent years. Increasingly policy and decision makers are looking for indicators and tools that can help them inform decisions, as well as to facilitate the transition towards a more sustainable economy. At the same time, many researchers have developed diverse types of indicators that measure pathways to a greener economy or a more sustainable development. However, at the moment these indicators are not often enough used, partly because of the scarcity of databases that are able to aggregate the numerous indicators available, as well as provide stakeholders information about the strengths and weaknesses about each of the indicators available. NETGREEN is a research project that has developed a systematic and consistent overview on the existing efforts to measure sustainable development and the transformation towards the green economy. The project aims to simplify the use and interpretation of indicators for stakeholders that are searching for available indicators, as well as understand the linkages between the indicators and the themes and issues addressed by each indicator. This has been done through the development and promotion of an interactive online indicator database in the form of a website www.measuring-progress.eu. The website allows the user to combine different ways to search for indicators, which include keyword search, topic navigation and free text search, to allow users with different needs to use the website in an intuitive way. Selecting the diverse options available, the user will obtain an indicator selection, and for each indicator a set of metadata information and links to international databases having the available data. The information provided about the indicators supports the user in identifying suitable indicators, and in understanding the information that results from using each of the indicators proposed. Moreover, the database supports the interpretation of the indicators results, as well as identifying indicators limitations and providing suggestions for alternative indicators. This can help the database users to understand the complementary viewpoints that arise from using different indicators to support the processes of decision making. Additionally, NETGREEN aims to serve as a focal point of the discussions on the measurement of the green economy, and further develops the exchange of information, establishing a communication platform that brings together diverse types of stakeholders, such as academics, policy makers, statistics officials, NGO's, among others. This platform can also foster the debate on the use of indicators in the discussions about green economy and ways the measure sustainable development.

Sustainable development of coal mining in Poland

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Abstract

Energy is one of the most important human needs. Nearly 87% of the energy in the world is generated in the combustion process of fossil fuels, including 30% share of coal. Renewable energy sources over the past three decades have shown a significant increase in the range of energy needs, but in the future they themselves will not be able to provide the required amount of energy in a stable manner. At the same time the world's fossil fuels resources are being depleted.

Poland has substantial coal resources, which cover about 53% of domestic demand for primary energy. It is also the most important raw material for the Polish energy sector: it is the source of 82% of the total electricity produced in Poland. At the same time, due to decrease in coal prices on world markets, the Polish mining industry faces difficulties. Nowadays, there are ongoing discussions on the future of the Polish mining industry.

After reviewing available substantial publications it can be stated that there are only a few publications devoted to sustainable development of hard coal mining industry in Poland. In the authors' opinion, there is a need for research on both current and past state of development of Polish hard coal mining industry (the period of 2007-2014 was examined).

The research was performed with use of multi-criteria decision-making method – the Analytic Hierarchy Process (AHP). In the AHP decision model 24 criteria were included and economic, environmental, and social aspects of the problem were analyzed. In the economic field, particular attention was paid to the coal production, revenues, costs, expenditures, liabilities and receivables of the hard coal mining industry and the market situation in the reviewed period. Environmental criteria included hard coal resources, pollutant emissions, waste rock management, costs and expenditure on environmental protection. In the social area, the sustainable development was analyzed in relation to the influence of the level of total employment in the hard coal mining industry, average wages, the number of accidents and payment of public-law liabilities.

The results achieved reveal that the small improvement of sustainable development had been observed in the analyzed period. The highest increase of aggregate indicator was noticed in the economic area, followed by the social area. The increase of the economic sustainable development is mainly the consequence of enhancing production of coking coal in analyzed period. The aggregate indicator in the environmental field showed decreasing tendency which can be the basis for understanding the improvement in the future.

The conducted research seems to be compliant with the current trends in scientific and academic elaborations on sustainable development and the authors intend to broaden their works to other energy resources in Poland.

Keywords: coal mining industry, sustainable development, Analytic Hierarchy Process, AHP

1. Introduction and justification of the expediency of the works undertaken

Energy is the basis of human functioning in almost all areas of economic activity. Its acquisition, processing and use helped to achieve the present level of development of the economy and civilization. Almost 87% of the energy in the world is generated by the combustion of fossil fuels, of which about 30% is coal (BP, 2015; Popławski and Dąsal, 2008; Pipitone and Bolland, 2009).

The advantage of coal over other fossil energy resources is its prevalence. Even though coal is often ousted by natural gas, its consumption, despite its reduced share in the global energy balance, will continue to grow. This is due to the ever increasing demand for energy. Long-term forecasts of global institutions indicate an average annual growth of coal consumption of around 2.5% (IEA 2014). Thus, it is expected that for a long period of time coal will remain the dominant fuel for power generation around the world, particularly in many countries of Central and Eastern Europe (Dubiński and Turek, 2012; Skvarekova and Kozakova, 2012).

Poland has considerable coal resources and is now one of the ten largest producers of this raw material in the world. Coal mining is one of the pillars of Poland's economic development and the mineral plays a key role in ensuring the country's energy security. Coal covers about 53% of primary energy demand in Poland. It is one of the highest values in the world. Coal is also the most important raw material for the Polish energy sector, which uses it for producing 82% of the total electricity. It is expected in the forecast of demand for fuels and energy that in the near future no significant changes in the structure of raw materials for energy production in Poland will take place. According to the Polish Energy Policy until 2050, coal will remain the main source of power generation in the country (Burchart-Korol et al. 2014; Gawlik at al. 2013; Jeleń and Cała, 2012; PE, 2015).

Virtually every mining activity to a greater or lesser extent impacts the natural environment and shapes social space. Therefore, the condition for the development of the mining industry is to balance this process by reconciling the problems of securing energy needs and meeting the requirements of environmental protection, while ensuring the development of civilization of the society. Sustaining of the mining industry in Poland and its further development therefore requires tackling a number of challenges. The main challenge for the industry is a clear demonstration that it contributes to the prosperity and quality of life of the present generation without compromising the capacity of future generations to achieve a high quality of life. It is therefore important to monitor and evaluate the state of the domestic coal mining in the implementation of sustainable development (Azapagic, 2004; Dubiński, 2013; Szymkiewicz et al. 2010).

The concept of sustainable development is now a widely spread. It appeared in the second half of the twentieth century as a reaction to the rapid economic growth observed in many countries of the world, which is often associated with a very intensive and uncontrolled use of environmental resources. Therefore, to reduce this phenomenon, in the late 60s of the last century under the auspices of the United Nations, appropriate measures have been taken (Dubiński, 2013). Their effect was the Report of the World Commission on Environment and Development of the United Nations published in 1987 and entitled Our Common Future. The Commission's report defined sustainable development as "meeting the needs of the present generation without compromising the ability of future generations to meet their own needs" (WCED, 1987). This document, however, does not provide any guidance on how to implement sustainable development process in various industrial sectors. Brundtland Report (named after the President of the Commission) emphasizes that this is not possible due to various conditions concerning, inter alia, economic and political systems which operate in various sectors (NRC, 1995). The consequence of this are numerous proposals for the implementation of the process of sustainable development in various sectors of the economy including the mining industry. There are numerous publications that contain different interpretations of the application of sustainable development.

It should be emphasized that in Poland the principle of sustainable development has gained constitutional status and its definition is found in the Environmental Protection Law (Constitution of the Republic of Poland 1997, Environmental Protection Law 2001).

Implementation of the principles of sustainable development is the integration of actions in the following three key areas (Baran et al. 2011; Dubiński, 2013; Yu et al. 2008):

- technical and economic ensuring economic growth,
- environmental, guaranteeing the protection of natural resources and the natural environment,
- social, meaning care for the employee in the workplace and community development.

It is assumed that these areas are equally important, which determines the characteristic of their balance, therefore putting emphasis on just one area usually leads to a crisis in the whole area of operation of the mining sector. Therefore, sustainable development should secure a lasting improvement in the quality of life of present and future generations through the development of proper proportions in the management of three kinds of capital: human, natural and economic (Baran et al. 2011; Dubiński, 2013).

It should be emphasized that the sustainable development in each case is a continuous process rather than an ad hoc operation. It has clearly defined goals and means of achieving them, in each of the above key areas (Dubiński et al. 2007).

In order to support the decision-making process in the implementation of the sustainable development it is required to maintain measurements of its level and forecasting of the effects of decisions. A measure used for this purpose must be based on strong foundations and scientific merit (Su et al. 2010).

The article presents the results of research on the assessment of sustainable development of coal mining in Poland. Its aim was to provide information on changes in the development of the mining industry and to identify areas where it is possible and necessary to support this process. Efforts were made to determine the extent to which coal mining contributes to creating good economic and social conditions, and the extent to which it cares for the environment. The works were preceded by research for the development of an indicator measure providing a comprehensive assessment of the sustainability of the domestic coal mining.

2. Review of the literature

The need to develop an indicator assessing the degree of sustainable development has been recognized by a number of entities operating in the mining sector, including, among others, the US Sustainable Minerals Roundtable, the Canadian Minerals and Metals and the European Industrial Minerals Association. Some of these organizations are already actively contributing to the work aimed at preparation of indicators of sustainable mining development. However, these developments are only at the beginning and much more work is needed in this field (Azapagic, 2004).

Problems concerning the theory and methods of assessing the level of sustainable development have been repeatedly discussed, among others, in the works (Bond et al. 2001; Bossel, 1999; Lopez-Ridaura et al., 2002; Malkin-Pykh, 2002; Ronchi et al. 2002). Some of the proposed solutions were used to assess the level of sustainable development in renewable energy sources, mining (Hilson, 2001; Zhu et al. 2015), and agriculture. Some of the works refer to research conducted for Poland.

The results of the research were presented also in the field of measurement and evaluation of sustainable development in the mining industry. (Auty and Warhurst, 1993; Brown, 1993; Chen and Yan, 2008; Hilson and Murk, 2000; Su et al. 2010; Tilton, 1996; Yu et al. 2008) analyzed the coal mining industry, (Sera and Olsa) – the extraction of crude oil and natural gas. Measurement of sustainable development of exploitation of mineral resources was subject to the following works (Chen and Yan, 2008; Su et al. 2010). Research in this area was also conducted in Poland. The Burchart-Korol's team within the framework of the project titled "Development of an expert system to assess environmental, economic and social efficiency of coal mines in Poland", financed by the National Centre for Research developed an algorithm for the evaluation of sustainable development of coal mining and environmental performance (Burchart -Korol et al. 2014). This article proposes an approach for measuring sustainable development in the mining industry different from the one presented in that study, while contributing to the development carried out in this field of research.

The results of the work presented in this paper allow to trace the changes that have taken place over the years 2007-2014 in the coal mining industry in Poland in economic, social and environmental terms. This required the development of a meaningful indicator of an integrated assessment of sustainable development of coal industry. The model proposed by Azapagic (2004) was the starting point for assessing the sustainable development of the mining sector, however, it contains more than 132 indicators, which make the assessment difficult. Presented working model for assessing the level of sustainable development of mining is built with a view to its practical application, therefore, is based on the optimal number of indicators for which values are widely available.

3. Conceptual model

Assessment of sustainable development in the coal mining industry in Poland with its major objectives was carried out by a hierarchical indicator model.

To assess the state of sustainable development in coal mining, a list of 24 indicators was adopted in the study in order to partially assess the various aspects characterizing sustainable development within one of the three criteria, ie. economic, environmental and social (Fig. 1). These indicators are used to construct the index of aggregate assessment of sustainable development based on a additive aggregation formula. Aggregate indicator is the primary tool for monitoring the status of sustainable development in the mining industry for visualizing the very essence of the concept of evaluation of the state in measurable form (Burchart-Korol et al. 2014).

The choice of indicators was made on the basis of a review of literature (Azapagic, 2004; Paszkiewicz and Szadziewska, 2011; Shen et al. 2015; Si et al. 2010; Su et al. 2010; Yu et al. 2005, 2008; Yupu et al. 2012) so as to illustrate the degree of implementation of the objectives adopted in the mining industry contained in the definitions of sustainable development. It is by no means an easy task, because most of the phenomena described by indicators are of global character and affect numerous stakeholders (Azapagic, 2004).

Mining is divided into four sub-sectors: energy resources, metal ores, construction materials, industrial raw materials (chemicals). Although these four sub-sectors have much in common, in regard to the issue of sustainable development they are different, which imposes special caution in developing a set of indicators that will reflect the important internal and external factors determining the state of sustainable development of mining (Azapagic, 2004).

Indicators have been chosen to refer to events measured in both general and detailed way, thus covering the whole problem. Selected indicators are quantitative. Table 1 contains the proposed set of indicators for partial assessment.

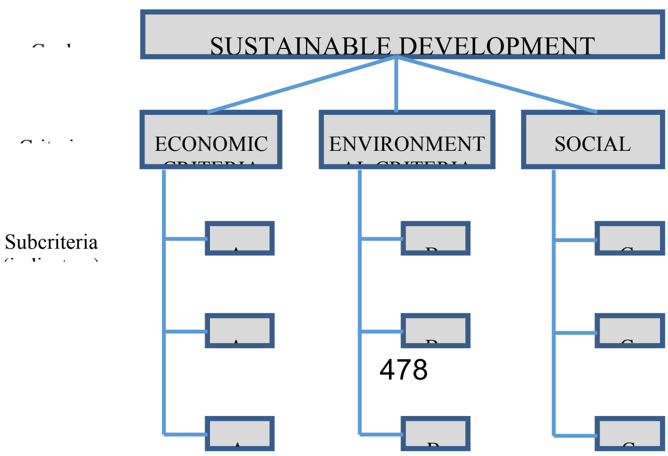

Fig. 1. The hierarchical model of evaluation of the state of sustainable development.

Source: own study.

Table 1. Indicators for partial assessment of the state of sustainable development of coal mining in Poland

Criterion	Indicator	Significance	Unit
Economic	A_1	Coal production	Mg
	A_2	Income	PLN/Mg
	A_3	The costs of coal mining	PLN/Mg
	A_4	Total capital expenditures	PLN/Mg
	A_5	Total liabilities	PLN/Mg
	A_6	Total receivables	PLN/Mg
	A_7	Labor productivity per person employed in the coal sector	Mg/person/year
	A_8	The share of sales of coal in the Polish market	%
	A_9	The ratio of coal export/import	%
Environmental	B_1	The amount of balanced resources of coal	Mg
	B_2	Total production of rock mass and mining waste	Mg / Mg
	B_3	Management of waste rock underground	Mg / Mg
	B_4	The fees charged for use of the environment	PLN/Mg
	B_5	Capital expenditures in the coal mining industry for environmental protection	PLN/Mg
	B_6	Energy intensity (consumption of fuels and energy)	MJ / Mg
	B_7	Dust emissions	Mg / Mg
	B_8	Gas emissions - total	Mg / Mg
Social	C_1	Expenses incurred for repairing damages	PLN/Mg
	C_2	The number of people employed in the coal sector	persons
	C_3	The average annual salary of employees in the coal sector	PLN/person/year
	C_4	The number of accidents in the coal mining industry	pcs/person
	C_5	Expenditure on health and safety in coal mines	PLN/Mg
	C_6	The number of identified occupational diseases in the mining industry	pcs/person
	C_7	Public and legal payments	PLN/Mg

Source: own study.

Values for some indicators of the partial assessment of the state of sustainable development in the mining industry are based on the actual statistics reported by the mining industry. The data used in the study with an annual interval covers the period from 2007 to 2014.

Majority of indicators is expressed either as absolute values in the analyzed period, in our case - for a year (eg. Mg of extracted coal / year) or as relative values (eg. the number of employees / Mg of extracted coal).

Some of the indicators are expressed in different units of measure, therefore, it was necessary to bring them to comparable value (transition to unitless values). Therefore, standardization was conducted, and if it was necessary, also quotient conversion.

The standardization process was carried out using the formulas (1) and (2). In the case of the use of simulations, the following formula may be used:

$$Yit=IitIi0 \tag{1}$$

where:

I_{it} – the value of the *i* indicator in the year *t*,

I_{i0} – the value of the *i* indicator in the base year.

Destimulants were standardized according to the formula:

$$Yit=Ii0Iit \tag{2}$$

where:

I_{it} – the value of the *i* indicator in the year *t*,

I_{i0} – the value of the *i* indicator in the base year.

An important stage in the development of the aggregate indicator reflecting the state of sustainable development in the mining industry was to determine the validity of indicators, namely assigning weights. Weights of the individual characteristics play an important role in the overall assessment of the analyzed events, because they can significantly affect the final results of the analysis. For individual indicators as components of a given component of sustainable development, the weights were assigned as advised by experts, using the Analytic Hierarchy Process (AHP) method.

4. Analytic Hierarchy Process

The complexity of reality enforces decisions based on many different (often conflicting) criteria at the same time, taking into account both positive and negative impacts. Making wrong or accidental decisions can be significantly reduced through the use of Multiple Criteria Decision Making (MCDM) methods. These methods are included in the field of operations research, and the most important include (Trzaskalik, 2008; Sobczyk et al. 2014):

- MODM Multi-Objective Decision-Making Methods - methods of multipurpose decision-making,
- MADM Multi-Attribute Decision-Making Methods – methods of multi-attribute decision-making, also referred to as discrete multi-criteria method.

MADM is dominated by the use of tools such as PROMETHEE (Preference Ranking Organization Method for Enrichment Evaluations), ELECTRE (Elimination Et Choix Traduisant la Realite), TOPSIS (Technique for Order Performance by Similarity to Ideal Solution), SMART (Simple Multi-

Attribute Rating Technique), AHP (Analytic Hierarchy Process), ANP (Analytic Network Process) (Harputlugil et al. 2011; Kwaśniewski et al. 2015; Mathiyazhagan et al. 2013).

The most attractive of them, in the context of the pursued objective of research, seems to be the Analytic Hierarchy Process which is a multi-criteria mathematical model that supports decision-making processes.

AHP is a method where more than one criterion is present and at least two-piece, finite set of decision variants is considered. In addition, this method allows for comparing quantitative and qualitative criteria (Sobczyk 2008; Bascetin 2009).

The choice of the AHP method was dictated by its particular characteristics such as (Haq and Kannan, 2006; Kannan et al. 2008; Lewis et al. 2006; Saaty 1986, 1990, 1996, 2000; Sambasivan and Fei, 2008):

- built-in flexibility, simplicity and logical brevity (consistency),
- the possibility of decomposition of complex decision problems into smaller problems in a hierarchical criteria, sub-criteria or attributes,
- the opportunity to include experts' opinions affecting the relativism of impacts of individual decision-making criteria on the evaluation results.

Figure 2 presents a solution scheme for the problem presented in the work in terms of the aggregate assessment of sustainable development in the coal mining industry in Poland.

In the first stage, the required data was collected, and the research problem was decomposed into uniform decision-making areas, to which appropriate criteria and the criteria of a lower order were assigned. These criteria have been developed, inter alia, as a result of the review the literature in the field of coal mining in Poland and methods for measuring its impact on the environment. Economic, environmental and social criteria were distinguished together with indicators within them.

Afterwards, experts were surveyed. This way, the relative strength of some specified criteria and indicators was determined in relation to one another by comparing them in pairs. As a result, a matrix of relationships was constructed between the subordinate and overriding criteria, assigning the right priorities to them.

Subsequently, normalization of criteria was carried out, eliminating the discrepancies and differences in the data. For each matrix the maximum value of its own matrix λ_{max}, was calculated and using the following formula (Sobczyk, 2008):

$$\lambda max=1ni=1n\lambda i$$

and

$$\lambda i=i=1naij\cdot wiwi$$

where:

λi – matrix's eigenvalue,

aij - an element of the matrix,

$wiw=(wi,\ldots, wn)$ - elements of the eigenvector.

Quality of the assessment was verified by controlling the consistency ratio CR. The value of consistency ratio CR is determined according to the formula:

$$CR=\lambda max-n(n-1)\cdot RI$$

where:

λ_{max} – maximum eigen value,

n – the order of the matrix,

RI – the random consistency index.

RI value is adopted depending on the size of the matrix. Table 2 shows the RI values for the size of matrix from 1 to 10.

Table 2. Average random consistency index (RI) based on matrix size

n	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
RI	0	0	0.52	0.89	1.11	1.25	1.35	1.41	1.45	1.49

Source: (Saaty, 2000)

The last step was to calculate the value of aggregate indicator for the assessment of sustainable d**e**velopment of coal mining in Poland, based on the following formula:

$Zt=t=1mWi\cdot Yit$

where:

W_i - weight of the *i*, indicator,

Y_{it} – the value of the standardized *i* indicator in the year *t.*

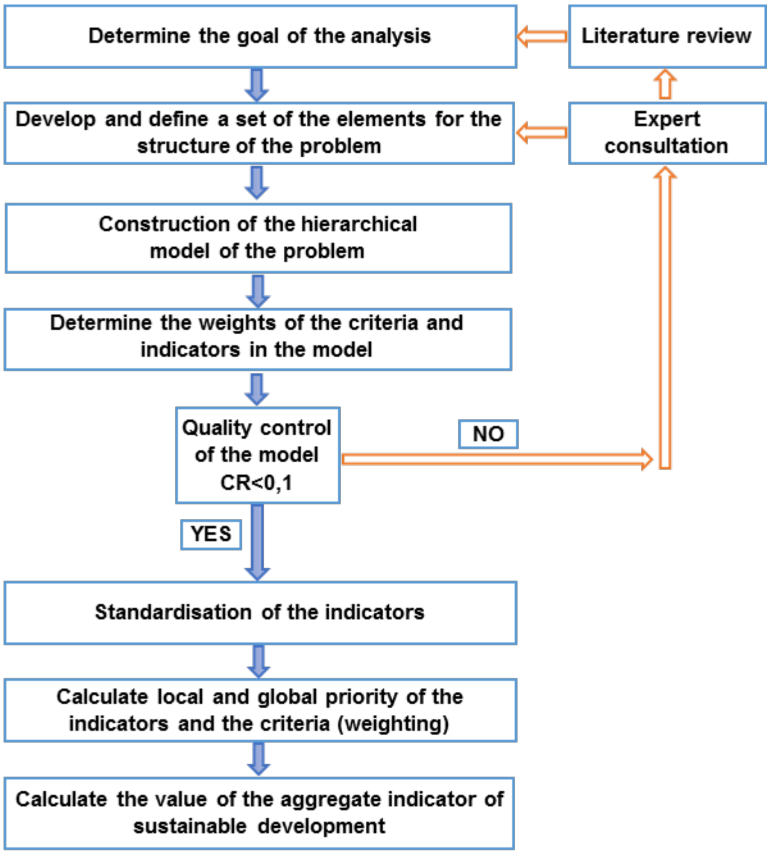

Fig. 2. The workflow for determining the indicator for assessment of the state of sustainable development.

5. Calculations

The above-described approach was used to calculate the aggregate value of an indicator for the assessment of the level of sustainable development of the coal mining industry in Poland. The indicators presented in Table 1 within particular criteria were evaluated in pairs in order to determine their relative importance and assign weights to them. The assessment process was attended by 10 people, including experts in the field of mining and scientists from the Mineral and Energy Economy Research Institute of Polish Academy of Sciences, and AGH University of Science and Technology in Krakow. The analysis used a nine-point scale proposed by (Saaty, 2000). It is described in Table 3.

Table 3. Scale of preferences between two elements

Preference scores	Definition	Explanation
1	Equally important	Both the elements have equal priority
3	Moderately important	One element is moderately favored over the other.
5	Strongly important	Experience and judgment strongly recommend to prefer one element over the other

7	Very strong importance	An element is given very strong preference over another and its dominance demonstrated in practice
9	Extremely strong importance	The evidence favouring one activity over another is of the highest degree possible of affirmation
2, 4, 6, 8	Intermediate values between two adjacent judgments	Used to represent compromise between the preferences listed above

Source: (Saaty, 2000)

The values of the conducted comparative evaluation were averaged and used for calculating the weights for the indicators analyzed in accordance with the schedule of conduct described in Chapter 4. Matrices of preferences for each criterion, together with the weights of indicators are presented in Tables 4-6.

Table 4. Matrix of preferences with weights of indicators for the economic criterion (A).

	A_1	A_2	A_3	A_4	A_5	A_6	A_7	A_8	A_9	Weight
A_1	1.00	5.00	4.00	8.00	6.00	8.00	5.00	3.00	5.00	0.3192
A_2	0.20	1.00	3.00	5.00	7.00	7.00	6.00	5.00	5.00	0.2311
A_3	0.25	0.33	1.00	5.00	3.00	7.00	3.00	1.00	3.00	0.1177
A_4	0.13	0.20	0.20	1.00	0.33	3.00	0.20	0.20	0.33	0.0280
A_5	0.17	0.14	0.33	3.00	1.00	3.00	0.33	0.33	0.33	0.0415
A_6	0.13	0.14	0.14	0.33	0.33	1.00	0.20	0.20	0.33	0.0192
A_7	0.20	0.17	0.33	5.00	3.00	5.00	1.00	0.50	0.50	0.0695
A_8	0.33	0.20	1.00	5.00	3.00	5.00	2.00	1.00	3.00	0.1083
A_9	0.20	0.20	0.33	3.00	3.00	3.00	2.00	0.33	1.00	0.0655

Table 5. Matrix of preferences with weights of indicators for the environmental criterion (B).

	B_1	B_2	B_3	B_4	B_5	B_6	B_7	B_8	Weight
B_1	1.00	3.00	8.00	0.50	2.00	1.00	1.00	0.20	0.1041
B_2	0.33	1.00	4.00	0.14	1.00	0.17	1.00	0.20	0.0459
B_3	0.13	0.25	1.00	0.11	0.25	0.11	0.25	0.11	0.0177
B_4	2.00	7.00	9.00	1.00	7.00	1.00	6.00	0.50	0.2216
B_5	0.50	1.00	4.00	0.14	1.00	0.14	1.00	0.20	0.0474
B_6	1.00	6.00	9.00	1.00	7.00	1.00	7.00	0.33	0.2047
B_7	1.00	1.00	4.00	0.17	1.00	0.14	1.00	0.50	0.0660
B_8	5.00	5.00	9.00	2.00	5.00	3.00	2.00	1.00	0.2926

Table 6. Matrix of preferences with weights of indicators for the social criterion (C).

	C_1	C_2	C_3	C_4	C_5	C_6	C_7	Weight

C_1	1.00	0.14	0.20	0.50	0.33	2.00	1.00	0.0580
C_2	7.00	1.00	7.00	7.00	3.00	7.00	3.00	0.4193
C_3	5.00	0.14	1.00	5.00	3.00	3.00	3.00	0.2107
C_4	2.00	0.14	0.20	1.00	1.00	1.00	0.50	0.0645
C_5	3.00	0.33	0.33	1.00	1.00	3.00	1.00	0.1087
C_6	0.50	0.14	0.33	1.00	0.33	1.00	1.00	0.0525
C_7	1.00	0.33	0.33	2.00	1.00	1.00	1.00	0.0863

In order to determine the consistency of the matrix of preference, it was necessary to calculate the consistency ratio, CR. Given matrix was considered to be sufficiently consistent, when the value of CR was less than 0.1. For all three matrices the calculated CR value is less than 0.1 and so the matrices were found to be consistent.

Table 7 presents the standardized values of the indicators together with their weights. The source for the data were the materials obtained from: Mining State Authority (WUG), Central Statistical Office of Poland (GUS), Ministry of Energy (ME), Industrial Development Agency (ARP), Polish Geological Institute (PIG). Standardization was carried out on the assumption that the base year is 2007.

Table 7. Standardized values of indicators together with their weights for the A, B, C criteria.

Indicator	**Weight**	**Year**							
		2007	2008	2009	2010	2011	2012	2013	2014
A_1	0.1064	1	0.9570	0.8861	0.8713	0.8657	0.9065	0.8748	0.8296
A_2	0.0770	1	1.3403	1.2833	1.4362	1.8041	1.6129	2.0534	2.2611
A_3	0.0392	1	0.8520	0.8081	0.7622	0.6549	0.6755	0.4809	0.4174
A_4	0.0093	1	0.7264	0.6067	0.6356	0.5046	0.4731	0.5231	0.5286
A_5	0.0138	1	1.1425	1.2875	1.3352	1.4605	1.5838	2.0111	2.7633
A_6	0.0064	1	0.7634	0.7136	0.7211	1.0824	0.7000	0.5018	0.4651
A_7	0.0232	1	0.9654	0.8723	0.8900	0.8914	0.9767	0.9670	0.9668
A_8	0.0361	1	0.9498	0.9302	0.8994	0.8926	0.9371	0.9525	0.9468
A_9	0.0218	1	0.3944	0.3961	0.3682	0.1883	0.3609	0.5501	0.4545
B_1	0.0347	1	0.9802	1.0034	1.0241	1.1012	1.0940	1.1663	1.1787
B_2	0.0153	1	1.0790	1.0596	0.9589	0.9610	0.9719	0.9116	0.8186
B_3	0.0059	1	0.7817	0.6540	0.6824	0.5698	0.4507	0.4552	0.6159
B_4	0.0739	1	1.0337	0.8470	0.7546	0.8761	0.7997	0.7828	0.7359
B_5	0.0158	1	0.5701	0.3479	0.4111	0.5519	0.6532	0.4258	0.7020
B_6	0.0682	1	0.9929	0.8552	1.0044	1.0265	1.0882	1.0248	0.9679
B_7	0.0220	1	0.9570	1.1392	1.1202	1.1130	1.0198	0.7158	0.6222
B_8	0.0975	1	1.0043	0.9192	0.9286	0.9999	1.0543	0.9908	0.9815
C_1	0.0193	1	1.0515	0.8126	0.8584	0.6534	0.6798	0.7339	0.6870
C_2	0.1398	1	0.9913	1.0158	0.9790	0.9712	0.9281	0.9047	0.8581
C_3	0.0702	1	1.0279	1.1378	1.1600	1.1820	1.3796	1.3413	1.5289

C_4	0.0215	1	0.9390	0.7919	0.8305	0.9283	1.0326	1.1438	1.1623
C_5	0.0362	1	1.1852	1.3422	1.3646	1.4525	1.5036	1.5230	1.5395
C_6	0.0175	1	0.9880	1.1311	0.8870	0.9664	1.1241	1.3515	1.0455
C_7	0.0288	1	1.1981	1.1787	1.4785	1.7001	1.3844	1.3751	1.2337

On the basis of standardized data and weights, values of aggregate indicator Z_t for the assessment of sustainable development of coal mining in Poland were calculated. The resulting values of the indicator in the years 2007-2014 are shown in Table 8 and in Fig. 3.

Table 8. Aggregated indicator for assessing the status of sustainable development

Indicator	Year							
	2007	2008	2009	2010	2011	2012	2013	2014
A	0.3153	0.3234	0.3456	0.3423	0.3748	0.3914	0.3333	0.3312
B	0.2960	0.3002	0.3218	0.3244	0.3040	0.2980	0.3333	0.3273
C	0.3570	0.3602	0.3698	0.3759	0.3778	0.3752	0.3460	0.3570
Z	0.9683	0.9838	1.0372	1.0427	1.0566	1.0646	1.0045	0.9683

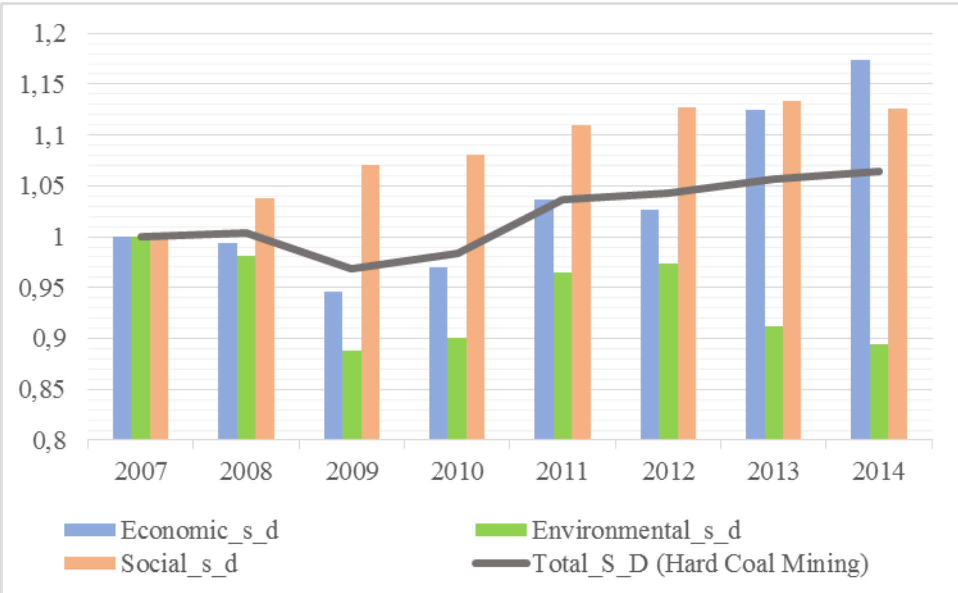

Fig. 3. Integrated calculation of sustainable development indicators.
Source: own study.

6. Results and Conclusions

As a result of the conducted analyses, an assessment of sustainable development of coal mining industry in together with its changes in the years 2007-2014 was carried out. Hard coal mining in Poland plays an important role in the economic development of the country. To assess the condition of sustainable development of the industry one of the methods for multi-criteria decision-making was applied, the so-called AHP (Analytic Hierarchy Process) hierarchical model. It contained a total of 24 evaluation criteria in economic, environmental and social areas. The evaluation of sustainable development was carried out with the help of experts in various fields related to coal mining.

In the analyzed period one may observe an increase in the aggregate indicator of sustainable development in the period 2009-2014, which follows two years of depreciation of its value. The strongest growth rate is observed in the economic area (growth exceeds 17.4% in this period), followed by the social area (increase of 12.5%). In the environmental area, the value of the indicator shows a downward trend (falling by a total of 10.6% by 2014), which should be the basis for verification of the industry's actions in order to improve the influence on the environment. Improving the value of the index of sustainable development in the economic dimension is mainly due to changes in the level and structure of coal mining (despite the decrease in the total production, the share of coking coal - which has better prices - increases). The increase in the social area is dictated mainly by an increase of the average salary in the mining industry and increasing expenditures on health and safety despite their small share in the aggregate indicator. The decreasing value of the expenditure earmarked for environmental protection in coal mining is the most important reason for decline in the value of the indicator in this area. The value of the indicator in the environmental area is largely shaped by the level of total gas emissions, energy consumption of the industry and fees charged for the use of the environment.

The conducted research fits the current trends for sustainable development and will be continued by the authors also for other energy resources in Poland. The method of assessing the sustainable development of coal mining industry in Poland can be used by the decision makers for:

- shaping the strategy of development of the mining industry, in terms of available capabilities - to improve the negative impacts of the industry on the environment,
- assessing the impact of coal mining on national sustainable development indicators,
- evaluating the effectiveness of mineral resources management.

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Towards Sustainable Drinking Water Treatment – the Application of Natural Coagulants in the Removal of Emerging Contaminants

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Abstract

The industrial development associated with world population growth has risen issues about clean and sanitized water and water scarcity. This rapid development contributes actively to the contamination of fresh water supplies with organic and inorganic compounds, potential harmful to health and environment. Emerging contaminants - anthropogenic-based contaminants - enter into surface waters reservoirs for human water consumption, contaminating environment and endangering human health. Since drinking water quality has been a worldwide major concern for the last decades with the treated water meeting the standards for chemical and microbiological quality, traditional processes use chemical-based coagulants such as aluminium-based, ferric salts and synthetic organic polymers. Despite of their efficiency and simplicity, these coagulants are expensive and harmful to human health, like alum that has been associated with the development of Alzheimer's disease and the synthetic organic polymers are associated to neurotoxic and carcinogenic effects. Also these chemical-based coagulants produced a large volume of contaminated waste sludge which are a major environmental issue. With the extensively use of chemical-based coagulants, traditional water clarification methods using natural coagulants were abandoned in developed countries. As a future strategy the application of natural "green" coagulants to water treatment emerges as a promising ecologically, socially and economically sustainable option and readily available alternative to the hazardous chemical-based coagulants. Natural coagulants, like plant extracts, are available in abundance, safe to human health, eco-friendly, and in general toxic free. They are also non-corrosive which eliminates the concerns of pipe-erosions and their application decrease up to five times the production of sludge and with a higher nutritional value, reducing the operation and handling costs of the potable water production, improving the sustainability of water purification process. Furthermore, the raw plants extracts used in natural coagulants are often available locally and their application provide an extra cost savings and, hence a low cost and more sustainable option. The goal of the present work is develop, improve and implement this ground-breaking concept to increase the sustainability and improve the safety of potable water production by reducing the input of chemical in the treatment process. Applying to worldwide conventional water treatment two different natural green coagulants, carob and *Moringa*, the removal of ibuprofen, a pharmaceutical emerging contaminant, from surface water was access. As abundantly available, low-cost and renewable resources, carob (South of Portugal) and *Moringa* (Brazil), were chosen to be investigate for possible use in drinking water systems in order to favour the sustainability of the conventional treatment. The preliminary results are very promising, with a significant removal of ibuprofen by the natural coagulants, without compromising the removal of other compounds. However, the locust bean gum obtained from the seeds of the carob tree was more effective. One of the major concerns of using natural coagulants in drinking water treatment identified in preliminary results is the increase of dissolved organic carbon, thus a new approach is being tested by combining conventional treatment with a natural adsorbent to improve the overall process efficiency.

Keywords: Emerging contaminants, Water treatment, Carob, Moringa, Sustainability.